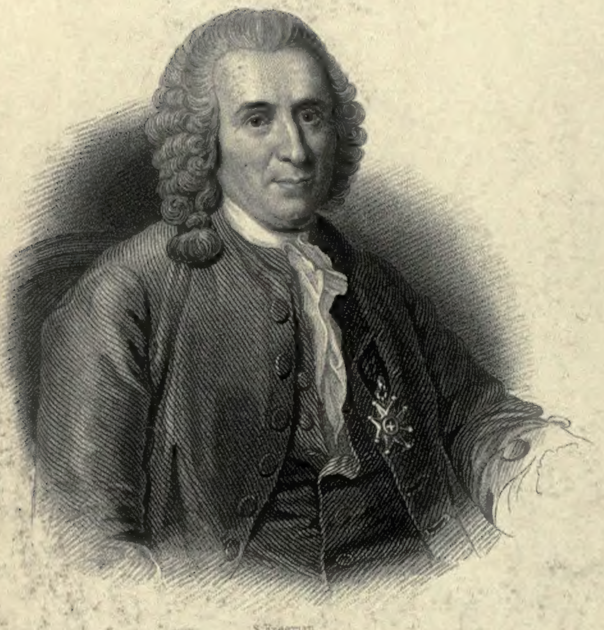


S. Freeman

LINNÆUS

Published by Blackie & Son, Glasgow.

A HISTORY
OF THE
VEGETABLE KINGDOM.
BY
WILLIAM RHIND.

ILLUSTRATED BY SEVERAL HUNDRED

ENGRAVINGS ON WOOD & STEEL.

BLACKIE & SON, QUEEN S^T GLASGOW

SOUTH COLLEGE S^T EDINBURGH & WARWICK SQUARE LONDON.

A HISTORY

OF

THE VEGETABLE KINGDOM;

EMBRACING

THE PHYSIOLOGY OF PLANTS,

WITH

THEIR USES TO MAN AND THE LOWER ANIMALS,

AND THEIR APPLICATION IN THE

ARTS, MANUFACTURES, AND DOMESTIC ECONOMY.

BY WILLIAM RHIND,

LECTURER ON BOTANY, MARISCHAL COLLEGE, ABERDEEN.

ILLUSTRATED BY SEVERAL HUNDRED FIGURES.

Lucem Libris Disseminamus.

LONDON:
BLACKIE AND SON: PATERNOSTER ROW;
AND GLASGOW AND EDINBURGH.

MDCCCLXVI.

GLASGOW:
W. G. BLACKIE AND CO., PRINTERS,
VILLAFIELD.

PREFACE.

THERE is, perhaps, no department of science with which so many delightful associations are connected as the study of Botany. The gorgeous beauty and periodical verdure of trees and flowers, the economical utility and medicinal virtues of many plants, and their general application in the commonest arts of life, have attracted the admiration and secured the attention of mankind from the earliest ages; and still continue to be objects of the greatest importance.

While it has been the purpose of the present volume to present to the general reader a comprehensive and popular description of all those Vegetables which claim an interest, either for their beauty, utility, or rarity, it has also been deemed of importance to give the physiological history and classification of Plants in such detail as may be of utility to the more systematic student of Botany.

The FIRST PART of the Work, therefore, consists of the physiology, geographical distribution, and classification of Plants.

The SECOND PART embraces a history of Plants used for food and clothing; in arts and manufactures; in medicine; and for ornamental purposes.

The CONCLUDING PORTION treats of the practical culture of Plants, the preservation of specimens, and the drying of roots and seeds.

In a popular Work of this nature it was found impossible to proceed altogether on a strictly scientific plan; but so far as was practicable, the Natural method of arrangement has been adopted. Thus, in treating of individual plants, the great leading divisions of the vegetable kingdom have been followed; and in a considerable number of cases, the species have been grouped under their natural families. In general, however, the arrangement must be considered as made subservient to the grouping of vegetables according to their economical uses, as those employed for food, clothing, dyeing, medicine, and ornament.

To remedy this irregularity, a chapter has been devoted to an account of the systems of classification, and notices of the Natural families of plants have been arranged and inserted under the respective divisions. A compendium of Fossil Botany has also been added, as forming an interesting addition to the existing genera of plants.

The authors whose works have chiefly afforded the varied materials of this volume, are so generally referred to in the pages of the work, that it will be unnecessary to recapitulate them in this place, farther than to state, that to the French work of the younger Richard on Physiological Botany; to Sprengel, Mirbel, De Candolle, Dutrochet, Keith, Lindley, &c., frequent reference has been made.

In the practical and ornamental departments, much assistance has also been obtained from Loudon's highly useful works on Botany and Horticulture.

WILLIAM RHIND.

PREFATORY NOTE TO THIS EDITION.

In this re-issue considerable improvement has been made on the wood engravings interspersed throughout the text; and TWENTY-NINE new plates have been added to the original series. *Seven* of these illustrate groups of plants, including pines, palms, cacti, tree ferns, Australian trees and shrubs, and the characteristic features of a tropical forest. The remaining *twenty-two* are coloured after nature, and present faithful representations of plants important for their uses to man; comprising such as are most extensively used in medicine and the arts, and those from which food, spices, and clothing materials are obtained. The plants figured in the new plates, so far as not previously noticed in the body of the work, are described in an Appendix, in which the portion on Australian plants, contributed by a botanist long resident in these colonies, is new and of much interest. References will be found in the list of illustrations to the pages in which the various figures are described.

GLASGOW, 1855.

CONTENTS.

LIST OF ENGRAVINGS ON STEEL.

PLATE I.

EXHIBITS SECTIONS OF VARIOUS WOODS, HIGHLY MAGNIFIED.

PLATE II.

GEOGRAPHICAL DISTRIBUTION OF PLANTS, WITH REGARD TO ALTITUDE.

The mountain on the left represents one of the Andes in South America.

The mountain on the right represents the British zones of climate.

PLATE III.

FUNGI, OR MUSHROOM PLANTS.

PLATE IV.

PALMS.

PLATE V.

ALGÆ, OR MARINE PLANTS.

ADDITIONAL PLATES,

NOT IN

FORMER EDITIONS.

PLATE XVI.

PALMS, PINES, &C.

PLATE XVII.

PINE TREES.

PLATE XVIII.

SCENE IN A BRAZILIAN FOREST.

PLATE XLI.

AUSTRALIAN TREES AND SHRUBS.

COLOURED PLATES.

PLATE XIX.

MEDICINAL PLANTS.

PLATE XX.

MEDICINAL PLANTS.

PLATE XXI.

MEDICINAL PLANTS.

PLATE XXII.

MEDICINAL PLANTS.

PLATE XXIII.

SPICE PLANTS.

PLATE XXIV.

SPICE PLANTS.

PLATE XXV.

GUM PLANTS.

PLATE XXVI.

GUM PLANTS.

PLATE XXVII.

PLANTS USED AS FOOD.

INDEX TO THE ENGRAVINGS ON WOOD.

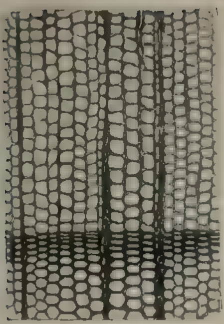


Fig. 4.

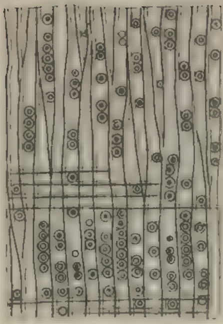


Fig. 5.

Fig. 6.

Fig. 1.

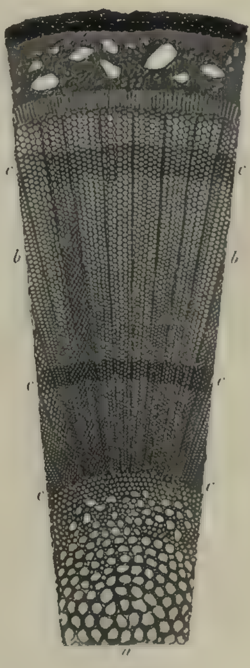


Fig. 2.

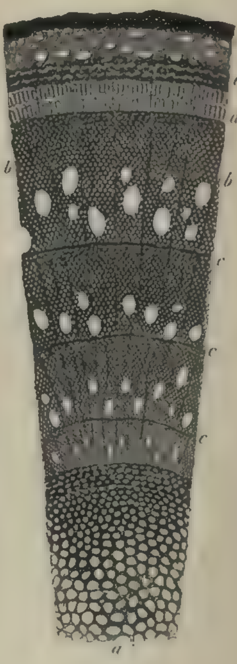


Fig. 3.

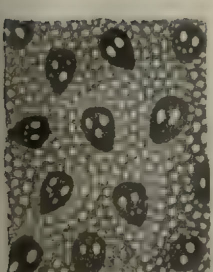


Fig. 7.

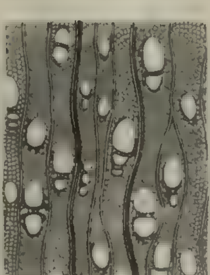


Fig. 8.

Fig. 9.

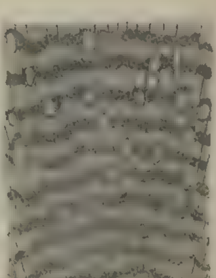


Fig. 10.

PLATE II

PL. XLIV

PLATE III

P. E. XCVIII

PLATE IV

MONOCOTYLEDONOUS PLANTS — PALMS

P.E. CXXXIV.

PLATE V.

Blackie & Son

PLATE VI

PLATE VII

PLATE VIII

PLATE IX

PLATE I

PLATE XI

PLATE XII

PL. CXXXIII PLATE XIII.

P E XVI

PLATE XIV

PLATE XV.

PLATE XVI

PLATE XVII

SENNA.
Cassia acutifolia.

COLOCYNTH.
Cucumis colocynthis.

JALAP.
Exogonium purga.

CASTOR OIL.
Ricinus communis.

MEDICINAL PLANTS.

PLATE XX

PERUVIAN BARK.
Cinchona condaminea.

OPIUM POPPY.
Papaver somniferum.

SCAMMONY.
Convolvulus scammonia

NUX VOMICA.
Strychnos nux vomica.

RHUBARB.
Rheum palmatum

ALOE.
Aloe Socotrina

GENTIAN
Gentiana lutea

CAJEPUT.
Melaleuca leucadendron

IPECACUAN.
Cephaelis ipecacuanha

SQUILL.
Scilla maritima

SARSAPARILLA.
Smilax sarsaparilla

COPAIBA.
Copaifera officinalis

NUTMEG
myristica moschata

CINNAMON.
laurus cinnamomum.

CLOVE.
caryophyllus aromaticus

ALLSPICE or PIMENTO.
myrtus pimenta.

GINGER.
zingiber officinale.

BLACK PEPPER
piper nigrum

CAPER.
capparis spinosa

CAYENNE PEPPER
capsicum annuum

GUM ARABIC.
Acacia seyal.

GUM TRAGACANTH.
Astragalus tragacantha

GUM OLIBANUM.
Boswellia serrata

GUM MASTIC
Pistacia lentiscus.

GAMBOGE.
Hebradendron gambogioides

BENZOIN.
Styrax benzoin

CAOUTCHOUC
Siphonia elastica

GUTTA PERCHA
Isonandra gutta.

PLANTS USED AS FOOD.

COFFEE.
coffea Arabica

TEA.
thea viridis

CHOCOLATE.
theobroma cacao

BREAD FRUIT.
artocarpus incisa


MAIZE
Zea Mays
MILLET
Sorghum vulgare

ARROWROOT
Maranta arundinacea

MANIOC OR CASSAVA
Janipha Manihot

YAM
Dioscorea alata

SWEET POTATO
Ipomaea batatas

WOAD
Isatis tinctoria

WELD
Reseda luteola.

MADDER

SUMACH

PLANTS USED IN DYEING — *PLATE XXXII*

SAFFLOWER
Carthamus tinctorius

FUSTIC
Maclura tinctoria.

BRASILWOOD
Caesalpinia crista

LOGWOOD
Haematoxylon campeachianum

COTTON
Gossypium Barbadense

FLAX
Linum usitatissimum

NEW ZEALAND FLAX
Phormium tenax

HEMP
Cannabis sativa

FOOL'S PARSLEY.

CUCKOO PINT or WAKE ROBIN

WHITE BRYONY

GREATER or COMMON CELANDINE

COMMON WOLF'S BANE or MONK'S HOOD.

DEADLY NIGHTSHADE or DWALE.

WOODY NIGHTSHADE or BITTER SWEET.

COMMON THORN APPLE.

COMMON HEMLOCK.

BLACK HENBANE.

STRONG SCENTED or POISONOUS LETTUCE.

AUTUMNAL MEADOW SAFFRON.

VEGETABLE POISONS

RANUNCULUS ALPESTRIS

ALPINE WHITE CROW-FOOT.

FLY BLOWN MUSHROOM

DIGITALIS PURPUREA

PURPLE FOX GLOVE.

BLACK HELLEBORE or CHRISTMAS ROSE

PLATE VII

3

A

HISTORY OF THE VEGETABLE KINGDOM.

CHAP. I.

THE HISTORY OF BOTANICAL SCIENCE.

In a survey "of the Earth and Animated Nature," one important part of creation comes to be considered—the Vegetable products which clothe and adorn the surface of the soil, and which form a link, and a most important one, between inorganic matter and the animated beings existing upon the globe. In order to enhance our ideas of the beauty and usefulness of vegetables, we have only to picture to ourselves what would be the appearance of the face of nature without them. We would have the surface of the earth, it is true, portioned out into hill and valley, and intersected at convenient distances by streams and rivers; but every thing would be bare, rugged, and unseemly, and nothing but a picture of desolate barrenness would appear. Even the soil which covers the sterile and flinty rocks, and which serves to fill up and smooth over the abrupt ravines and precipices existing in these, would, in a great measure, be wanting; for one effect of vegetation is, by the successive decay of leaves and fibres, to accumulate the deep black loam so essential to the growth of fresh vegetation. The endless variety of objects in the vegetable kingdom, the beautiful forms, and the curious structure of plants, are no less interesting to the student of nature, than the history of animals, or of inorganized matter. Nor is the study less important, as bearing upon the necessities, conveniences, and elegancies of life.

The study of the vegetable kingdom has been called Botany, from a Greek word, βοτανη, signifying herb or grass; and it embraces, 1st, A knowledge of the various parts composing plants, and of their uses, their mode of growth and culture, and their diffusion over the earth. 2d, An arrangement of plants into classes and families, according to certain prevailing resemblances, by which they are named and described, so that they may readily be known. 3d, The various uses of plants, as for food, medicine, arts and manufactures. The profusion with which the beneficent God of nature has clothed the earth with every variety of vegetable form, is truly wonderful! Every region of the globe swarms with multitudes of different kinds, beyond the power of the botanist to enumerate. The contemplation of these affords an ever-varying delight to the senses, while the investigation of their habits and structures no less agreeably exercises the judgment. A tree is perhaps one of the most noble and beautiful objects in nature. The massive strength of the trunk, the graceful tortuosity of the branches, and the beautiful and variegated green of the leaves, are all so many sources of pleasure to the beholder. But when we think of the series of fibres and tubes by which this tree for ages, perhaps, has drawn nourishment from the earth, and by a process of assimilation, added circle after circle of woody matter round the original stem, till it has acquired its present enormous bulk; when we reflect on the curious mechanism of the leaves by which, like the lungs of an animal, they decompose the air of the atmosphere, selecting through the day what part of it is fit to enter into the composition of the tree, and giving out at night a different species of air; when we think of the sap passing up the small series of tubes during summer, and these tubes again remaining dormant and inactive throughout the long winter—these reflections awaken a train of ideas in the mind more lasting and more intense than even the first vivid impressions of simple beauty.

The attention of the earliest races of mankind must have been directed to the vegetable kingdom; first of all, as furnishing important necessaries of life, and afterwards as objects of luxury and ornament, and pleasing subjects of speculation. We find Noah represented as a husbandman, planting the vine and manufacturing its juice

into wine, then at a subsequent period the Ishmaelites trafficking in spicery, balm, and myrrh, which they carried down from Gilead to Egypt in the days of Joseph. There is every reason to suppose that Solomon, who in his writings seems to have been a warm admirer of plants and flowers, wrote a distinct treatise on vegetables. Thus, in the book of Kings it is said, "He spake of trees, from the cedar tree that is in Lebanon, even unto the hyssop that springeth out of the wall." Of the nature of his treatise, however, we can now form no speculation. The silence of sacred history, therefore, leaves us in the dark with regard to the prosecution of botany as a science, and for this we must turn to the philosophical schools of ancient Greece. At first, among this intellectual people, it was the physiology of plants which was cultivated; because, from the small number of plants which were then known, and which among the Greeks and Romans scarcely exceeded a thousand, it was not found necessary to think of classifying them. Besides, the views of the ancients with respect to natural bodies, were entirely confined to the explanation of phenomena, and to the employment of the objects of their research in the arts. Hence in the writings of the Greek philosophers which have reached us on this subject, we find chiefly some physiological notions on the life and nourishment of plants, which they endeavoured to explain by analogies from the animal kingdom, with speculations respecting the rank which plants hold in the scale of natural bodies, and respecting their relations to animals. At the most flourishing period of the Greek republic, there were persons called Rhizotomæ, who devoted themselves exclusively to the digging of roots and finding of herbs, for the advancement of the arts, particularly that of medicine. Some of those who, devoting themselves to the latter employment, were called Pharmacopolæ, seem even to have issued from the schools of the philosophers, and to have acquired for themselves a comprehensive knowledge of plants; whence, also, they were called Cultivators of Physics. But the greater number pursued their occupation as market criers, and observed a multitude of superstitious customs, on which account they are rather to be regarded as traders than as men who had been trained in a scientific manner. The first founder of the natural science of plants was undoubtedly Aristotle, who hence sometimes was surnamed the Pharmacopolist, as having employed himself collecting medicinal plants. Unfortunately, however, his genuine works on plants have perished; a treatise on this subject, attributed to him, being a forgery of the middle ages. Theophrastus, the pupil of Aristotle, also cultivated the science of botany after the system of his great master. But he seems to have undertaken few journies or travels, since he always appeals to the testimony of diggers of roots, the cutters of wood, and the inhabitants of the mountains. He wrote two works which have been preserved; one on the nature and causes of vegetation, the other a history of plants. In these, we do not find either a very scientific arrangement, or precise description of the few species known to him; yet they possess no small merit, as being the production of a philosopher, who, almost without predecessors, endeavoured, for the first time, to employ the reasoning faculty upon the phenomena of the vegetable world. But he found none of his disciples worthy of being a successor to himself, and after his time the science declined and was very little cultivated.

When Greece was subdued by the Romans, the knowledge of the conquered so far passed over to the victors, that the latter, who always sought out only what was useful, cultivated the study of plants to as great an extent as it afforded advantages to the arts. In the works of the old Romans, Cato, Varro, and Columella, on rural affairs, as well as in the poetry of Virgil, we find a number of plants named which were cultivated in the fields and gardens. We have no reason to believe, however, that the study of plants was pursued with any degree of avidity among this people, as the Romans, like the early Greeks, were yet too much engaged in the tumult of war to have acquired any considerable relish for the study of natural history. And hence, the first direct evidence of the existence of any inquiry, that can be called strictly botanical, among the Romans, is that which is furnished in the works of Dioscorides and Pliny; names well known in the annals of botany, and illustrious as having long been regarded by the learned as the best and most infallible guides to the study of plants. Dioscorides lived in the first century of the Christian era. He was a physician, and followed the Roman armies in their expeditions through the greatest part of the Roman empire. His work consists of a description of all those plants known to possess medicinal virtues, and was long looked up to as the source of all information on this subject. Pliny the elder, who also flourished during the same era, and occupied a conspicuous station in the state, left behind him a great work on natural history. In that part of it devoted to the vegetable kingdom, the plants are arranged in alphabetical order, and the descriptions of Theophrastus and Dioscorides are followed. Here and there some notices are added, and plants are described which were unknown to his predecessors; and he himself has informed us, that, in his youth, he acquired his knowledge of plants in the garden of Antonius Castor, a son in law of King Dejotanus. Among the later Romans, the number of persons who cultivated the knowledge of nature, diminished in propor-

tion as the night of barbarism descended, and for a long time the remains even of Greek and Roman learning were entirely hid. The Arabians, indeed, after they had instituted schools of learning, infirmaries, and laboratories, applied themselves diligently to the study of medicinal plants; but they drew their knowledge entirely from Dioscorides.

The flourishing trade which this nation carried on for some centuries, from Madeira to China, made them acquainted with many remarkable oriental plants which had escaped the notice of the Greeks. There were also, in the western parts of the Arabian empire, some inquisitive students of nature, who endeavoured to correct and extend their knowledge by travel. About the beginning of the eleventh century, the Arabians became the teachers of the other nations of western Christendom, who now formed their schools of learning according to the Mahommedan pattern, and translated their books from the Arabians. In this manner, a slight knowledge of botany was slowly disseminated throughout the most enlightened parts of Europe.

At the revival of learning in the fifteenth century, the botanical knowledge of the ancients began to be available in the language of the original treatises; and, in the following century, the Germans commenced original inquiries into the science, and first began to illustrate their treatises, by wood engravings of the different plants. The first work of this kind was written by Otto Brunfels, a native of Strasburgh. To this succeeded, about the middle of the sixteenth century, the work of Gesner, a professor of Zurich, in which the first attempts are made at a classification and systematic arrangement of plants, founded chiefly on the characters of their flowers. The taste for Botany, now excited, began to spread throughout the chief states of Europe. Kings and nobles engaged in the study, and gardens were established for the cultivation of the most rare and useful productions of the soil. We are principally indebted to the establishment of learned societies, in the seventeenth century, and to the invention of the microscope, for the first attempts at a more minute examination of the structure of plants. In the Royal Society of London for the promotion of science, which was liberally supported by Charles II. several philosophers occupied themselves with the dissection and microscopical examination of plants. Of these, the most distinguished was Nehemiah Grew, secretary to the society. His discoveries are recorded in his elaborate work the Anatomy of Plants illustrated by numerous engravings. In this work we find the first notice of the twofold sex of plants, which doctrine he had learned from Thomas Millington, a professor in Oxford. Malpighi and Leuwenhoeck also distinguished themselves as investigators of the minute structure of plants; and, the same subject was ardently pursued by several members of the French Academy of Sciences, founded in 1665. The doctrine of the sex of plants, which had been obscurely hinted at by Grew, was experimentally illustrated by Bobart, and fully established by Ray.

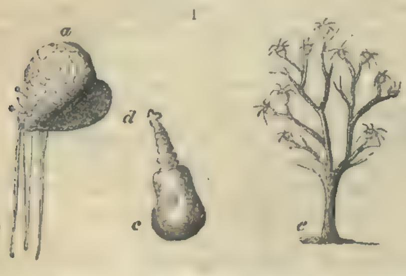
But with this increasing knowledge of the nature of plants, and the rapid multiplication of known species, no method of arrangement had yet been adopted calculated for general use, and especially for the guidance of the practical student. In this crisis of botanical perplexity, when specimens were every day multiplying in the hands of collectors, and the science was in danger of relapsing again into an absolute chaos, a great and elevated genius arose, destined to restore order; who, surveying the immense mass of materials, with a sagacity and penetration unparalleled in botanical research, and seizing, as if by intuition, the grand traits of character calculated to form the elements of a philosophical division, detected the clew by which he was to extricate himself from the intricacies of the labyrinth, and rear the superstructure of a new method. This great and illustrious naturalist was the celebrated Linnæus. He was born at Roshult, in Sweden, in 1707, and performed in 1732 his memorable journey through Lapland. He afterwards travelled into Holland, became superintendent of the Clifford gardens, and published his System of Nature at Leyden in 1735, and the Genera Plantarum in 1737. In 1741, he was appointed a professor of the University of Upsal, and continued for many years the successful cultivator and illustrator of his favourite studies. He has the merit of having first regulated, and defined the artificial language of botany. He fixed the laws of classification, and divided the vegetable kingdom into classes, families, and species; invented scientific, and common, or trivial names, and enriched the science by many thousand new and hitherto undescribed plants. But, above all, he invented what is denominated the artificial mode of arrangement, by taking the parts of inflorescence, as the flower or corolla, and stamens, and pistils, or distinctive sexual organs, as the basis of his system. Since the death of Linnæus, the chief labours of botanists have been employed in perfecting his system, in applying it to the lowest families of plants, in the more careful examination of fruits and seeds; and, in short, rendering it a convenient alphabet, by which the student of botany may be enabled to know and recognize the families and species of plants. A more philosophical view of the vegetable kingdom, based on the natural affinities of plants, has also been sedulously pursued by Jussieu, Decandolle, and many other eminent botanists.

CHAP. II.

THE NATURE AND USES OF PLANTS.

Vegetables differ from minerals in being organized bodies, possessed of a degree of life, and capable of taking into their system extraneous matters, and converting these, by an assimilating process into new compounds, which matters are thus rendered subservient to their growth and development. They thus increase their own bulk, and, moreover, throw off from their bodies germs which spring up into other vegetable bodies, the same as the parent plants. Vegetables, also, are under the dominion of the laws of vitality, by which they retain the matters entering into their structure, in a state different from that in which inorganic bodies exist. The matter, too, which enters into the composition of vegetables, is essentially the same as that which forms the structure of animals; the chief elementary ingredients being oxygen, hydrogen, carbon, and azote; only, the proportions and combinations are somewhat different; vegetables possessing more carbon and less azote than the generality of animals. In these respects, vegetable bodies closely resemble animals; indeed, in the lower divisions of each, the resemblance is so close, as to render it a somewhat difficult task to point out the distinctive differences. We find no hesitation in drawing a line of distinction between the more perfect plants, and a quadruped, bird, or fish; but, if we take some animals low in the scale of organization, and compare them with certain simple vegetables, we shall find the resemblance, both of structure and functions, very close indeed. Thus, the *Lemna Gibba*, or duck weed, a plant which is found floating on the surface of the water of ditches, and slow running streams, has an oval, cellular body *a*, with several porous roots *b*, which, unlike most other vegetables, are unattached to the soil, but which float in water, and absorb moisture to constitute the juices of the plant. This moisture flows up into the cellular body, and hence, by the medium of pores on the cuticle, or skin, a quantity of air from the atmosphere is absorbed, and thus converted into the proper nourishment of the plant. In the *Cysticercus*, *c*, a species of animal hydatid, which lives within the cavities of the bodies of other animals, there is a neck *d*, with a tubular mouth, by which the animal draws in the juices on which it feeds, to its stomach. The skin of this animal is also porous, like the epidermis of the *lemna*, through which fluids, and perhaps air, are absorbed into its body, to conduce to its nourishment. In the tubipore *e*, consisting of a branched stem, with numerous cups, each containing a simple animal called a polype, there is a close resemblance to the arborescent form of most vegetables.

1



Yet, though plants and animals thus resemble each other very closely, in many essential particulars there are others in which they differ. Thus, in animals which have the power of locomotion, there is a muscular system, a set of contractile fibres, whose tension or relaxation determines their movements; in vegetables, there is nothing of the kind. Animals have a stomach, or receptacle, for the substances taken from without, in which these are digested before they are carried, by means of the lacteals, into the mass of their circulating fluids; but in vegetables, nutrition is carried on in a more simple manner The substances absorbed are conveyed directly into all parts of the body, without undergoing any previous change, so that, in these, we find neither an intestinal canal, nor a stomach, because there is no proper solution or digestion. In animals there is more or less of a circulation of the fluids from a centre; in vegetables the nutritious juices are diffused through the plant without the agency of a central heart. Plants derive their nourishment from inorganic matters, from air, water, and the various salts of the soil; animals derive their chief nutriment from matter that has been previously organized, either from vegetable substances, or the bodies of other animals that have enjoyed an organized existence. Animals have a nervous system and sensation; the meanest animal form shrinks from the touch of an opposing object, and evidently exhibits the indications of pain and pleasure. Plants have no nervous system, neither are they capable of external impressions of sensation. Dutrochet, it is true, has pointed out minute granules in plants, which he assumes as analogous to the nervous granules of the lower animals, but this fact has not been yet sufficiently established. As plants perform vital functions so closely allied to the nutritious functions of animals, it is not altogether improbable but that some modification, or approach to nervous matter, may be found in their structure. If this shall be hereafter established, it will not, however, do away with the proposition above, that plants have, in reality, no sensation analogous to that of animals. They have a contractile power of their fibres, which acts on the

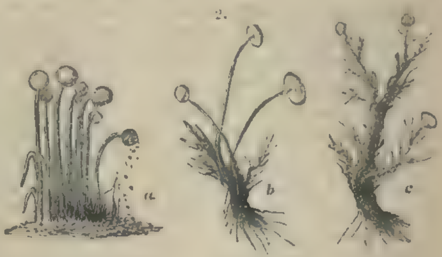
application of external stimulants, remarkably displayed in the sensitive plant, and in the turning of leaves and tendrils towards the light and air; this, which has been termed irritability, is widely different from the true sensitive perceptions of animals.

But, though vegetables thus differ materially from animals, in having no sensation, nor any medium of communication with external things, they yet are possessed of the essential properties of life. Like animals, they are acted upon by the external agencies or stimuli of life, as heat, light, air, moisture, and electricity; and the vital laws by which they are governed, place them in a totally different position from inorganic matter. In the tubes of vegetables, the sap ascends from the earth, contrary to the laws of gravity; and the juices, and the whole material of the plant, as long as it is possessed of life, resist the common chemical laws of decomposition: but, whenever it is cut down, or deprived of life, these juices immediately run into fermentation, and again return to the elementary matters of which they were originally composed. Vegetables are destitute of voluntary motion. Some of them, however, execute a species of locomotion, or very simple change of place. The *Lemna*, or duck weed, floats in water, yet this is merely a passive motion. The roots of many of the family of the Orchis, have two fleshy tubercles placed side by side, at the base of the stem. One of these tubercles, after giving birth to the stem, whose germ it contained within it, withers, contracts, and ultimately perishes. But, in proportion as it disappears, a third grows out close to that part which still contains the rudiments of the stem, which is to appear in the following year, and replaces the former when it has vanished. In this development of a new tubercle occurring each year, on one side of those which already exist, it will be seen that, when a new stem is produced, it is removed by a certain space from that which preceded it. The same thing happens, and nearly in the same manner, in regard to the meadow saffron, with the exception that its bulbs tend continually to sink deeper and deeper in the earth.

The number of vegetable forms on the surface of the globe is immense. At least 50,000 distinct species have already become familiar to botanists, and as every new exploration of recently discovered regions is adding rapidly to the list, the probability is, that at least twice this number exists in nature. The past history of the earth, too, informs us that many vegetable forms, which once flourished in great luxuriance and profusion, are now swept from the soil, and no longer exist, but in their fossil forms in the rocks and strata.

As is the case in the animal kingdom, we find that the tribes and families of vegetables vary exceedingly in their forms and sizes. Some are so minute as to be invisible to the naked eye, others rise to the height of 150 and 200 feet, and occupy an area of several square yards with their ramifying foliage.

The lowest tribes of vegetables are not only minute, but very simple in their structure. The



blue mould *a*, found in bread and other farinaceous articles of diet, when examined by the microscope, will be seen to consist of a number of upright stalks, surmounted by a spherical ball at the top. This mould is in fact a species of fungi, and the round heads contain innumerable small black seeds or sporules, which, when the plant has arrived at maturity, burst from their covering, are scattered about, and floating through the atmosphere, are ready to fall upon other pieces of bread, and grow up into fresh fungi. If an apple is cut across, and allowed to remain in a damp situation for a few days, the surface will also be covered with a mould of a similar character. The fungi here have even more of the arborescent form, and approach somewhat to the mosses. Figure *b* represents the apple mould; *c*, the pear mould. The gray lichens which so abundantly encrust rocks and stones are also simple vegetables, produced from a small seed, which, fixing itself on the flinty rock, by means of a tough mucilaginous juice, becomes the centre from whence others radiate, till a large circular patch is produced. Mosses and ferns are vegetables somewhat more complicated; and hence we ascend to herbs and shrubs, the towering palm and the majestic oak of the forest.

The use of vegetable products to man, and other higher animals, is obvious to every one. The paramount importance of the vegetable kingdom, as forming an essential link in the great system of nature, may be very shortly pointed out.

Vegetables clothe the surface of the soil, affording protection to the smaller animals, mitigating the arid effects of the sun, and preventing the disintegration of surface from the effects of the elements. They also preserve the purity of the atmosphere, absorbing the excess of carbonic acid, generated by the respirations of animals, and giving out, by the decomposition of water, a quantity of oxygen to make up for that consumed by the animal kingdom. Vege-

table actions also have a considerable influence on atmospheric electricity, and on the humidity and dryness of the air.

Vegetables so assimilate inorganic matters, as to convert them into the food of animals; every animal, either directly or indirectly, deriving its chief nourishment from vegetable products. No animal is found capable of supporting itself on air, water, or earthy matter alone. Fishes and birds prey upon minute flies and insects, which derive their nourishment from vegetable matters. Numerous quadrupeds derive their sole support from grasses, and many species of birds from grain and seeds. These become the prey of flesh-feeding animals, and afford them their sole means of subsistence; and man, as well as some other animals, lives both on vegetable and animal matter.

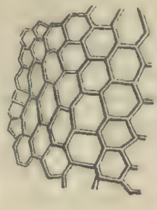
The vegetation of former ages, floated down by rivers, and accumulated in the earth's strata, has been converted into coal, to supply the wants of man under a changed climate. Lastly, the decay of vegetation is continually forming fresh soil, by which fresh plants are reared, and newly found countries are rendered habitable. Thus, a seed of a minute lichen clings to a bare and barren rock; others spring from the parent, and accumulate round it; in process of time they decay, new ones succeed them, and thus a sufficient soil is formed for the seeds of larger and more perfect plants.

CHAP III.

THE STRUCTURE OF PLANTS.

Plants are said to be organised bodies, because they have a structure quite different from that of inorganic substances; a structure made up of cells, fibres, tubes, and membranes, which join together to form distinct parts and organs. Some have endeavoured to trace this structure to certain primitive forms, existing in the rudest beginnings of vegetables, as well as in all parts of perfect plants. When vegetable matter is examined by the aid of a microscope, we discover more or less of these forms. In the lowest organic bodies, both of the animal and vegetable kingdom, we find, by the aid of a powerful magnifier, a spherical structure intermixed with *spiculi*, or threads, in the fluids and solids composing their parts. The simplest plants, as well as the infusory animalcules, have this structure. Treviranus saw it in the spawn of frogs, and in the muscular texture of the higher animals, in the marrow of frogs, and in the nerves of the garden snail. We find the same combination of round bodies and threads, or spiculi, in the sap of plants; hence some have supposed, that from these are evolved the peculiar primitive forms of the vegetable kingdom. The structural forms found in vegetables may be reduced to three: the cellular, the tubular, and the spiral.

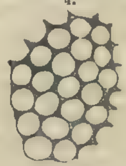
3.



a

The *cellular tissue* is composed of numerous cells contiguous to each other, of varied form, according to the resistance which they meet with, but generally assuming a six-sided structure, fig. *a*. Some have compared this cellular tissue to the froth or light foam which is produced by blowing up a mixture of soap and water; others have likened it to the combs of the honey bee, which, indeed, afford a very good illustration of its general appearance. Sometimes it assumes the simple form of a number of spheres slightly adhering together, fig. *b*. It was at one time generally supposed that the walls of two contiguous cells were common to both, till Malpighi conceived the idea that each cell was a distinct and perfect vesicle of itself, and which he termed *utricle*. This opinion has since been confirmed by Sprengel and numerous other observers. The cells may be separated without tearing, which proves that each cell forms a kind of small vesicle which has distinct walls, and that where the two cells meet, the membrane which separates them is formed of two layers, which belong respectively to each of them.

4.



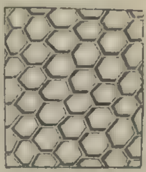
b

The investigations of Dutrochet and Amici confirm this opinion. This separation of the vesicles forming the cellular tissue, can be effected either by simple boiling in water, or in nitric acid; but the walls of the cells sometimes so intimately adhere to each other, that it is impossible to separate them. When we observe particularly the growth and successive formation of the cellular tissue, it will be distinctly seen that it is made up of cells at first insulated, but which, in process of their developement, become at last more or less united. In this tissue, the microscope displays to us oval or spherical bodies, generally of a green colour, but yet exhibiting all possible shades, according to the position in which they are observed. It is these small bodies that give colour to the cellular tissue, for the sides of the cells themselves are colourless and diaphanous. Turpin has called these bodies *globuline;* within each of them may be seen a small vesicle, in which other small granules are successively formed, which, arriving at their full development, burst asunder their enveloping cases. Each of these again becomes a small vesicle, in which new granules are

developed; and thus the cellular tissue, which forms the great mass of vegetable bodies, is produced in every part of the plant.

When the cells composing the tissue only meet with the equable resistance occasioned by the presence of the adjacent cells, it is no unusual thing to find them assuming a nearly perfect hexagonal form, or that of the cells of the honey bee, fig. *c*. But according to pressure, or the resistance they receive, they become more irregular, either elongated, rounded, or compressed.

5.



c

Fig. *d* exhibits a magnified view of those cells placed contiguous to each other. The walls of the cavities are thin and transparent; they all communicate with each other either by wide openings, or by pores or clefts in the thin walls. Some have supposed that the cells communicate with each other at a point where the walls are interrupted, while others have shown that the communication between the cells takes place only where the pores of their sides are invisible; thus rendering it probable, that it is by exudation that fluids pass from one cell to another. In the woody parts of trees, the cells are greatly lengthened, so as to form a species of small tubes which are parallel to each other; their walls are thick and opaque, and often become wholly obliterated. This elongated tissue exists in abundance in vegetables; it is much more common than the regular tissue, and is made up of small tubes which are contracted at different distances. Occasionally they taper towards the extremities. It sometimes happens that the cells of the elongated tissue touch one another only at their widest points, whenever intervals or empty spaces are found between them. According to some, these cells contain no liquid, but are filled with air. The medullary rays, to be afterwards described, form another modification of the elongated tissue; in these the cells are very small, elongated, and placed horizontally, instead of vertically.

6.

d

The cellular tissue has very little consistence; it is easily torn. In many vegetables, especially aquatic plants, there are interspersed around the tissue a number of large holes or lacunæ, filled with air, which, according to some, are rents or holes in the fragile tissue, while others suppose them regularly formed spaces. Sometimes hairs of a peculiar nature have been found on their inner surface, in the form of tufts or pencils. It is possible to distinguish two species of lacunæ; the one having for an orifice the cuticular pores which communicate with the external air, the others having no external communication. The latter exist particularly in plants which want the porous tubes. The use of the cellular tissue is simply to contain and prepare the sap. It is not destined to conduct upwards the unprepared sap, because in the bark and in the pith, both of which have a structure entirely cellular, the ascent of the sap is not perceived. There are, however, what have been called sap vessels in the cellular texture; but these, originally, are nothing else but extended cells, which are often stretched to a considerable length.

The *vascular vessels*, or *sap tubes*, are formed of layers of elementary cellular tissue, rolled up in such a way as to form canals or tubes, which are more or less elongated, and placed end on end, and whose partitions are often not to be seen. The walls of these tubes are sometimes pretty thick, slightly transparent, and perforated with a great number of openings, by means of which they diffuse into the surrounding parts a portion of the air or sap which they contain. These vessels are not continuous from the root to the top of the plant, but they frequently join with each other, and at last are changed into areolar tissue.

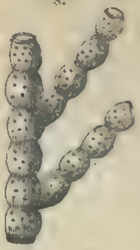
The different kinds of vessels are: simple tubes; the beaded or moniliform; the porous vessels; the slit vessels, or false spirals; the spiral vessels, and a combination of two or more of the above called mixed vessels.

Simple tubes. The simple tubes vary in size, but they are the largest of all the vessels, fig. *e*. They are formed of a thin and entire membrane, without any perceptible breach of continuity, and are found chiefly in the bark, although they are not confined to it, being met with both in the alburnum or newest formed wood, in the matured wood as well as in the fibres of herbaceous plants. They are particularly conspicuous in the stem and other parts of the different species of *Euphorbia*, and in all plants in general containing thick and resinous juices known by the name of the proper juices, to the ready passage of which their great width of diameter is well adapted. Sometimes they are distinguishable by their colour, which is that of the juices contained in them being white in the *Euphorbia*, yellow in the *Celandine*, or scarlet in *Piscidia erythrina*. In the plant they are united in bundles, but are detachable from one another by means of being steeped for a few days in spirit of turpentine, when they become altogether colourless and transparent, because the resinous matter which they contained has been dissolved. They retain their cylindrical form even in their detached state, so that the membrane of which they are composed must be very strong.

7.

e

8.



a

Beaded vessels. The moniliform, or beaded tubes, fig. *a*, are porous or punctuated, contracted at different distances, and crossed by partitions, which are perforated with holes like a sieve. These vessels are chiefly found at the junction of the root and stem, and of the stem and branches.

Punctuated vessels. These, fig. *b* are continuous tubes, on which are a number of opaque points; or, according to some, pores dispersed in transverse lines; hence Mirbel has called them porous tubes. They are found in most abundance in the stems of woody plants, and particularly in wood that is firm and compact, as the oak; but they do not, like the simple tubes, seem destined to convey any oily or resinous juices.—See section of oak, Plate 1, fig. *f*.

9.

b

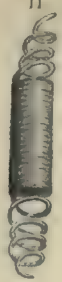
Slit vessels, or *false spirals*, fig. *c*. These are tubes with a number of slits in a transverse direction; they are very abundant in the woody layers and fibres of most species of vegetable productions, and serve, with the foregoing, as capillary tubes, through which the sap and juices of the plant flow. These tubes are apparently spiral on a slight inspection, but upon more minute examination, are found to derive this appearance merely from their being cut transversely by parallel tissues; they cannot, consequently, be uncoiled like the true spiral tubes; nor can they be separated into distinct rings, because the continuity of the membrane of which they are formed, and consequently the extremity of the fissure, which may always be discovered by a little attention, prevent that separation. They are somewhat similar to the porous tubes, for the fissures, like the pores, are furnished with a ring surrounding the top. But they are more generally found in the soft parts of woody plants than the porous tubes, and often also in the herbaceous plants. In ferns they are found in great abundance, and also in the soft parts of the vine.

10.

c

The *Spiral vessels*, fig. *d*. These are fine, transparent, and thread-like tubes, which are occasionally interspersed among the other vessels of the plant; but distinguishable from them by being twisted in a spiral form, either from right to left, or the reverse, somewhat in the manner of a cork screw. They are found in greatest plenty in herbaceous plants, and particularly in aquatic species; but they are also to be met with in woody plants, whether shrubs or trees. If the stalk of a plant of the lily tribe, or a tender shoot of elder, is taken, and partly cut across, and then gently broken or twisted asunder, the spiral tubes may be seen even by the naked eye uncoiled somewhat, but remaining still entire, even after all the other parts have given way; and if the inferior portion of the stalk is not very large, it may be kept suspended for some considerable time, merely by the strength of the tubes, which, though now almost entirely uncoiled by means of the weight they support, will, when they finally break, suddenly wind up at each extremity, and again resume their spiral form.

11



d

Grew and Malpighi, who first discovered and described them, fancied they resembled in appearance the *trachea*, or windpipe of animals; and hence described them by this name, under which they are still very generally known. Du Hamel endeavoured to convey an idea of their form, by comparing it to that of a piece of ribband rolled round a small cylinder, and then gently pulled off in the direction of its longitudinal axis. The figure of the ribband becomes thus loosely spiral. This is a very good illustration of the figure of the spiral tubes in their uncoiled state; but it does not represent them very correctly as they exist in the plant. But the best illustration of this kind is, perhaps, that of Dr Thomson. Take a small cylinder of wood, and wrap round it a piece of fine and slender wire, so as, that the successive rings may touch one another, and then pull out the cylinder. The wire, as it now stands, will represent the spiral tubes as they exist in the plant; and if it is stretched by pulling out the two extremities, it will represent them in their uncoiled state also. But although the spiral tubes are to be met with in almost all plants, they are not yet to be found in all the different organs of the plant; or at least, there are organs in which they occur but rarely, or in very small numbers. They do not seem to occur often in the root, or at least they are not easily detected in it. Grew and Malpighi do indeed represent them as occurring often in the root, the former referring for examples to the roots of plants in general, and the latter to those of the asparagus, poplar, convolvulus, elm, and reed, all of which, says Mr Keith, I have examined with great care, without being able to discover any spiral tubes. Sprengel states, however, that these spiral vessels are always in the company of the sap vessels, being chiefly found between the bark and pith in common plants; but they appear later than the sap vessels, and are only discerned when the young plant begins to shoot. They are, he adds,

found in the root as well as in the stalk; they partly compose the nerves and veins of the leaves and vessels of the corolla, and are found in the stamens and pistils in the fruit, and also in the umbilicus of the seed. These spirals, at their extremities, terminate in the cellular tissue, according to Mirbel; but according to Dutrochet, they end in a sort of cone, which is more or less acute.

If the root of the common garden lettuce is cut partly across, and the remainder broken gently asunder, the spiral vessels will most generally be discernible. They are not always simple, but are sometimes found with double, triple, or even with a great number of parallel spirals.

They may be also found in the leaf stalk of the common artichoke, when young and fresh, in the fibres of which, they are not only remarkably large and distinct, but also remarkably beautiful, some of them exhibiting in their natural position the appearance of spiral coats, investing interior fibres, rather than that of forming a distinct tube, and seeming, when uncoiled, to be themselves formed of a sort of net work membrane, consisting of three principal and longitudinal fibres. They are discernible also in the leaf as well as leaf stalk, though not quite so easily detected. If a leaf is taken and gently torn asunder in a transverse direction, there will be seen fragments of the spiral tubes projecting from the torn edges, and generally accompanying the nerves. In the calyx and corolla of the flower they do not exist so generally as in the leaf, on which account, some botanists have decided too hastily with regard to their non-existence in these parts. The calyx of the *scabiosa*, and the corolla of the honeysuckle, will afford examples. In whatever part of the plant they are found to exist, they are always endowed with a considerable degree of elasticity. For though they be forcibly extended so as to undo the spires, they will again contract and resume their former figure, when the extending cause is withdrawn; and if they are even stretched till they break, the fragments will again coil themselves up as before. Hedwig considered the spiral vessels composed of two parts: a straight and central tube full of air, and of a tube rolled spirally on the former, and full of aqueous fluid. Others have considered them as formed of a very thin external tube, in which a small silvery layer is rolled spirally, in such a manner as to keep its parietes or walls asunder; while again, some suppose that the spires of the vessel are held together by a very thin membrane, which is easily torn when the spiral thread is unrolled. From this it would follow, that the spirals form continuous tubes.

According to Decandolle, the interior canal of the spiral vessel, in its natural state, is always found free from water. It is true, that if a piece of wood is dipped in water, this fluid penetrates into the canal; and when we permit coloured fluids to flow into the cut branches of plants, these fluids become apparent in the sides of the spiral canals; but they are also seen still more distinctly, in the neighbouring bundles of sap vessels, and they penetrate in considerable quantity even into the cellular texture. We are not therefore, entitled from this entrance of coloured fluids, to conclude respecting the natural contents of those canals, because in general this penetration of coloured sap does not succeed in an uninjured root. In spiral canals which grow rapidly, the fibres are often torn in such a manner, that they fall together in the shape of rings. These ring-shaped vessels, as they have been called, are therefore an entirely accidental variety of the primitive form of the spiral vessels; and this is the more evident, because we find the same vessel in one situation as a spiral canal, and in another as a ring-shaped vessel. This change, besides, shows incontestibly that the spiral vessels cannot conduct sap, since they are often nothing else but rings at a distance from one another. As then the spiral vessels and all their varieties are uniformly found empty of fluids, as they show themselves only in the higher plants, and constantly appear wherever a strong shoot is cut off; as they are always in the company of the sap vessels, and as they maintain, by their constant diagonal direction, the middle situation between the perpendicular and horizontal; we must from all these considerations conclude that they are the instruments of the higher vital activity of plants, and that they are the organs by which the sap tubes receive an internal excitement to the speedy propulsion of the sap.

12

e

Mixed vessels, fig. *e*, are those which are composed of two or more of the foregoing varieties. Mirbel exemplifies this combination in the common flowering rush, in which the porous, spiral, and false spiral tubes appear united into one. He seems, however, to be of opinion, that the appearance is to be regarded as being merely an indication of the commencement of the process of union, of the contiguous rings of the spiral tubes, by which they are to be converted into a new form. Amici thinks that the false spirals never become true ones; and he besides remarks, that these two kinds of vessels occupy different places.

These various kinds of vessels thus united in considerable numbers, form bundles connected by cellular tissue; they then form fibres properly so called; and these fibres, or bundles of tubes, constitute the frame work, and, as it were, the skeleton of most of the organs of

vegetables. While the soft portion, composed of cellular tissue, is called the *parenchyma*, constituting the pulp of fruits, interstices of leaves, &c. This term is used in opposition to fibre, every part which is not fibrous being composed of parenchyma. These two tissues, combined in various ways, make up the different organs of plants; the vascular tissues consisting, as we have seen, of, 1st, The sap vessels, or lymphatics, in which the sap is circulated. 2d, The simple vessels, containing the peculiar or proper juices of the plant. 3d, The air vessels, in which we never find any thing but elastic gases. But the different writers on vegetable physiology are far from agreeing on the class to which the different species of vessels belong. Thus, many of the older, as well as the more recent writers in botany, are of opinion, as already stated, that the spiral vessels contain gaseous fluids alone, while Mirbel has denied the existence of air vessels at all, and maintains, that all the tubular vessels of vegetables are destined solely for the circulation of sap. Professor Amici, on the other hand, affirms positively, that he has ascertained by observation, that the spirals, the false spirals, the porous vessels, and in general all the tubular and cellular organs of vegetables which have visible holes or slits, never contain any thing but air. When the diameter of these tubes is large enough, this observation can easily be verified by cutting the tubes across, they are then observed to be always empty. If the division be made under water, each of them is seen to present a small air bubble at its orifice. The openings or pores with which the porous vessels are perforated, are very frequently organized like the pores of the epidermis or outer skin, that is, they present at their circumference a circular swelling, or border. This remark made by Mirbel, has been confirmed by Amici. From this resemblance the latter draws a conclusion which is favourable to his opinion, respecting the nature of the fluid contained in these vessels. In fact, the great pores of the epidermis never give passage to any other than elastic fluids. The air contained in the porous vessels does not communicate with the external air. Amici thinks it is produced in the interior of the vegetable tissue; but its nature is not as yet perfectly known. In woody vegetables, where the air vessels ultimately disappear, their place is occupied by the medullary rays, which perform the same functions. These are, in fact, composed of small tubes placed horizontally, or of porous cells elongated in a transverse direction, which seem to serve as a medium of communication between the inner parts of the vegetable and the outer. These tubes or cells never contain any thing but air. From the descriptions given then, it will be observed that there me two principal means of communication between the different parts of the vegetable tissue. In the air cells, or tubes, the communication is preserved by means of pores or minute slits. These pores are altogether wanting in the cellular tissue, properly so called; and in the vessels called simple tubes or proper sap vessels. In that part of the vegetable tissue, the communication takes place either by a kind of imbibition, or by the intervening spaces which the globules that compose the layers of that tissue leave between them.

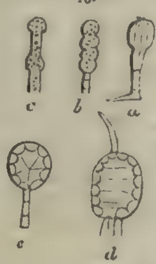
Pores. These are small and minute openings of various shapes and dimensions, adapted for the absorption, transmission, or exhalation of fluids; and have, by some, been classed under perceptible and imperceptible pores. The perceptible pores are either external or internal, and are the apertures described by Hedwig as discoverable in the net-work of the epidermis, or by Mirbel as perforating the membranes composing the cells and tubes, and forming a communication between them. The stomata or leaf pores, will be more particularly described when treating of the structure of leaves. They are found in considerable numbers in the softer parenchematous structure of the leaf, and rarely or never on the stems or fibres: on the under side of the leaf of nymphea or water lily, or on the lettuce or common cabbage leaf, they may be distinctly seen. On them they are, however, discoverable on both surfaces of the leaf, exhibiting an oval aperture more or less dilated, together with communicating ducts. On the upper surface they are much fewer and smaller than on the under; and in the leaves of trees, they are fewer and smaller on both surfaces, than in the leaves of herbs. They are generally oval; in the nymphea they are round and not readily detected, the epidermis of this plant being very difficult of detachment. The internal pores, or apertures, forming the medium of communication between the different cells and tubes, have been already described. In some plants, they are but few and scattered, and in others, they are numerous and arranged in regular rows, which extend always in a transverse, never in a longitudinal direction, being destined, probably, for the lateral transmission of the sap. The imperceptible pores are not distinguishable even by a powerful microscope; but they are presumed to exist by the evidence of experiment. In the fine pellicle of pulpy fruits, though exhibiting evidently traces of organization, no pores have as yet been discovered. But we must not on that account conclude that it is altogether without pores; on the contrary, we must assume their existence, because it is very well known that the fruits in question both absorb and transpire moisture; and if so, there must of necessity exist apertures for the passage of moisture. The diameter of such, however, must be extremely

minute. If an apple, or other pulpy fruit, be placed under the receiver of an air pump, and the receiver exhausted, the air contained in the apple escapes only by the bursting of the epidermis; hence it has been thought, that the pores are so very minute as to be impermeable even to air. But this conclusion is perhaps too hasty; the epidermis of the apple may be permeable to air, though not in a state of sudden expansion.

Gaps are empty spaces formed in the interior of the plant by means of a partial disruption of the membrane forming the tubes or utricles; they are often placed regularly and symmetrically. They would appear to be occasioned by the superabundance of the nutritious juices which their vessels are found sometimes to contain, without being able to elaborate, and by which they are ultimately ruptured. They do not occur often, except in plants of a soft and loose texture, such as aquatics, though they are sometimes to be met with in woody plants also. In their general aspect, they resemble longitudinal tubes interspersed throughout the cellular tissue or pulp, as may be seen in the stems of ferns; but in the mare's tail, (*equisetum*) they assume a regularity of disposition, that seems to indicate something more than merely the accidental rupture of the vessels. One gap larger than the rest occupies the centre of the stem, around which a number of smaller gaps are placed in a circular row, which is again encircled with a second row of gaps larger than the last, and alternating with them, and forming in their aggregate assemblage a sort of symmetrical group. In the leaves of herbaceous plants the gaps are often interrupted by transverse diaphragms, formed of a portion of the cellular tissue which still remains entire, as may be seen in the transparent structure of the leaves of *Typha*, and many other plants. Transverse gaps are said to be observable also in the bark of some plants, though very rarely.

Glands are peculiar organs which are observed on almost every part of a plant, and whose function it is to separate from the general mass of the sap of the plant some particular fluid or substance. In their uses, and even structure, they have a near resemblance to the glands of animals. They appear to be formed of a very delicate cellular tissue, in which a great number of vessels are ramified. But this name has been also given to vesicular bodies, which are often transparent and placed in the substance of organs, and are full of a volatile oil which has been probably secreted in their interior. Their peculiar form and structure are very various; and hence they have been distinguished into several species. Thus there are, 1st, *Miliary* glands. These are very small and superficial. They appear under the form of small round grains disposed in regular series, or scattered without order on all parts of the plant which are exposed to the air. 2d, *Vesicular* glands. These are small reservoirs full of essential oil, and lodged in the herbaceous integument of vegetables. They are very distinct in the leaves of the myrtle and of the orange, and appear under the aspect of small transparent points when those leaves are placed between the eye and the light. 3d, *Globular* glands. These have a spherical form, and adhere to the epidermis only by a point. They are observed particularly in the *labiatæ*. 4th, *Utricular* glands, or *Ampullæ*. These are filled with a colourless fluid, as in the ice plant. 5th, *Papillary* glands. They form a species of paps or papillæ, something like the papillæ of the tongue. They occur in many of the *labiatæ*. 6th, *Lenticular* glands. Some of these are borne upon stalks, others sessile, or attached to the plant without any appendage. Many tribes of vegetables, as the mallows and leguminous plants, bear on their pellicles, or on the disk of their leaves, glands of very various forms. Figs. *a b c*, represent the forms of the simpler glands; *d e* sessile glands.

13.



Hairs. These are small filaments of greater or less delicacy, found abundantly on vegetables, and which serve for the purpose of absorption and of exhalation. There are few plants destitute of these hairs; but they are observed chiefly on those which grow on dry situations. In this case, they have been looked upon by some botanists as serving to multiply and extend the absorbing surfaces of vegetables. Accordingly, they are not found on very succulent plants, such as the thick leaved or aquatic tribes. They appear also, to be in many cases the excretory ducts of many glands, and are thus frequently found inserted on a papillary gland. Thus, in the common stinging nettle, the hairs attached to the gland first pierce the skin, and then conduct the irritating fluid into the wound; for when this fluid is dried up, the prick of the hair no longer produces a painful sensation. Hairs have been divided into the glanduliferous, the excretory, and lymphatic. The first are either immediately applied to a gland, or surmounted by a small peculiar glandular body, as in the white fraxinella; the second are placed on glands of which they appear to be the excretory ducts destined to pour out the secreted fluids, while the third are only a simple prolongation of a cortical pore. Their forms are various, as the simple-branched, awl-shaped, head-shaped: some are hollow and cropped at different places by horizontal partitions. Their disposition and existence

on plants is called pubescence, and will be more particularly alluded to afterwards.

CHAP. IV.

THE ORGANS AND FUNCTIONS OF PLANTS.

In the foregoing pages we have treated of the general structure of vegetables; we now proceed to consider the several parts, or organs, of which a plant is composed. A perfect plant consists of a root, stem, and branches; leaves, blossoms, with the parts of fructification, seeds, and, lastly, fruit. The root, stem, and leaves, as conducing to the nutrition and growth of the plant, are called the conservative or nutritive organs. The flowers, with the parts of fructification, as contributing to the multiplication of the species, are termed the reproductive organs.* As there is a gradation, however, in the vegetable kingdom, many plants have not all the organs now enumerated. Some have neither leaves nor stem, others are destitute of flowers, or even seeds, and propagate their kinds by a simple sporule, which partakes as much of the nature of a bud or incipient germ, as a regular seed. Before proceeding to describe the organs in detail, we shall give a short, general view of the different parts of plants.

The first, or most perfect division of plants, is called *Phanerogamic,* or those having conspicuous blossoms. A plant of this class consists of, 1st, The root, or that part of the lower extremity of the plant which enters the earth, where it sends out filaments and fixes the plant in the soil, or, in a few aquatic plants, floats loose in the water. The use of the roots is to absorb the nutritive juices from the soil. 2d, The stem, which grows upwards into the atmosphere, and sends out branches, to which the leaves are attached. The stem contains the cells and sap vessels already described; it is covered with the bark, and gives strength and solidity to the plant. 3d, The leaves are those green membranous appendages attached to the branches of the stem, or they grow out immediately from the root in those plants having no middle stem. Their office is to absorb the gases of the atmosphere, which combine with the juices of the plant. 4th, The flowers or blossoms, containing the parts of fructification, to which are attached the fruit and receptacles of the seed. The flower consists of the *calyx* or cup attached to the flower stalk, on which is fixed the *corolla* or coloured portion of the flower, which may be either formed of one continuous piece, like a cup or bell, or of several pieces called petals. The parts of fructification consist of the *stamens* or male organs, with the *anthers*, filled with *pollen* or fecundating dust; and the *pistil* or female organ, occupying the centre of the flower, and terminating in an ovary or receptacle for the seeds. 5th, The *pericarp*, of very variable form and consistence, is the ovary or seed bag fully developed, and contains the ovules, which are in process of time matured into seeds. 6th, The seeds contained in the pericarp, are attached to it by a filament, called the *placenta.* They have an external skin or covering, and a kernel; within this is attached the embryo or germ of the future plant, and either one or two lobes or cotyledons, destined to afford the first nourishment to the germ. From the nature of the cotyledons, plants are divided into two great and distinctive classes: *Monocotyledonous* with one seed lobe, *Dicotyledonous* with two seed lobes. Of the former class are grasses, palms, lilies; to the latter belong the oak, elm, pea, carrot, and numerous other families. The acotyledonous class, again, includes those plants which have no seed lobe, and either no fructifying organs, or very imperfect ones.

But even among the first or highest class of plants, all the organs are not uniformly present. Thus neither the plantain, nor the common primrose, have any stem or stalk; there are no leaves in the dodder. In monocotyledonous plants there is no corolla or flower blossom around the parts of fructification, but only a simple integument; even this integument is in the willow awanting. Sometimes the blossom contains only one of the several organs, as in the hazel, where the stamens are found in one flower, and the pistils in the other, or both sexual organs disappear altogether, as in the viburnum, portencia, &c. Yet, in all these different exceptions, this absence of organs is only accidental, and has no marked influence on the rest of the organization; for it will be found that plants which want those organs, do not deviate essentially either in their external characters, or in their mode of vegetation and reproduction from those which possess them.

The second great division of the vegetable kingdom is into cryptogamic or acotyledonous plants. Linnæus gave them the name of crypto-

* Linnæus distributes the parts into root, herb, and fructification; the herb comprehending the trunk, branches, and leaves. This is perhaps sufficiently correct, considered as a division; but is objectionable with regard to the use of one of the terms employed. For as the term herb was previously appropriated to the designation of a peculiar class, or division of plants, it ought not to have been employed to signify also a part of the plant itself. Another division is that by which the parts in question are distributed into permanent, and temporary, or deciduous—the permanent parts being the root, stem, and branches, which continue to exist as long as the plant vegetates, and the temporary parts being the leaves, flower, and fruit, which fall off and are renewed annually, at least in those that are themselves perennial.—*Keith's Botany.*

gamic because their sexual organs are concealed or invisible; they include ferns, mosses, lichens, fungi, and algæ; they are a numerous class, and comprehend nearly an eighth part of the 50,000 known vegetable productions. The following table will exhibit at one view the foregoing statements:

Organs of Nutrition,	Root. Stem, branches. Leaves.
Organs of Reproduction,	Calyx, corolla. Stamen. Pistil. Ovary. Seed
Division I. Phanerogamic, or Flowering Plants,	Monocotyledonous—one seed lobe, as palms, grasses. Dicotyledonous — two seed lobes, as oak, elm, bean.
Division II. Cryptogamic, or Nonflowering,	Acotyledonous — destitute of seed lobes, as mosses, ferns, lichens.

CHAP. V.

THE ROOTS OF PLANTS.

The root is that part of the plant which, forming its lower extremity, is almost always concealed in the earth, and which grows constantly in a direction opposite to that of the stem, that is, it descends perpendicularly, while the other ascends into the atmosphere. Another character of the root is, that it never turns green, at least in its tissue, when exposed to the action of air and light; whereas all the other parts of vegetables acquire that colour when exposed. This definition is perhaps as comprehensive as any that can be given, whether with regard to the class of perfect or imperfect plants, though it is no doubt liable to many exceptions, if applied to both. For even of plants denominated perfect, some are found to float on the surface of the water, having the roots immersed in it, but not fixed, as the *lemna* or duck weed; and of plants of a still simpler structure, some have no root at all, or at least no visible part distinct from the rest, to which that appellation can be ascribed, such as many of the confervæ; or they are apparently altogether root, as the truffle. There are also many of the simpler plants which attach themselves to other vegetables, and to various substances from which they cannot be supposed to derive any sort of nourishment whatever, owing either to the mode of their attachment, or to the character of the substances to which they attach themselves. Such are many of the mosses, lichens, and marine plants, found adhering to the outer and indurated bark of aged trees, to dead or decayed stumps, to rotten pieces of wood, and frequently even to stones. These, therefore, are to be regarded as exceptions to the rule. Most aquatic plants, such as the buck bean, water lily, hooded milfoil, are possessed of two kinds of roots. The one, sunk in the earth, fix the plant to the soil; the other, usually proceeding from the base of the leaves, are free and floating in the midst of the water. The *Clusia rosea*, a shrub of South America, the *Sempervivum arboreum*, the Indian corn, the mangrove, and some species of figs, besides the roots which terminate them below, produce others from different points of their stem, which often descend from a considerable height and sink into the earth. These have received the name of adventitious roots; and a remarkable fact respecting them is, that they do not begin to grow in diameter till their extremities have reached the soil, and drawn from thence the materials of their growth. We must not confound as roots certain subterraneous stems of vegetables which creep horizontally under the soil, as in the German Iris, Solomon's Seal, &c. The direction of these alone in a horizontal, not perpendicular position, would be almost sufficient to distinguish them from the true roots if other characters did not mark them. Different parts of vegetables are capable of producing roots. Cut off a willow branch, or the branch of a poplar, plant it in the earth, and in the course of a short time its lower extremity will be covered with rootlets. The same will happen when both extremities are planted in the soil; each of them will push forward roots, and thus become fixed in the earth. In grasses, particularly in Indian corn, the lower knots of the stem sometimes give out roots, which descend and sink into the earth. It is on this property of the stem, and even of the leaves of many vegetables, of producing new roots, that is founded the practice of propagating by slips and layers, a means of multiplication which is much employed in horticulture. There is great analogy of structure between the roots which a tree shoots into the earth, and the branches which it spreads out into the air. The principal difference between these two organs, depends chiefly on the different mediums in which they are developed. The roots of the gigantic Baobab tree of Africa, are said to extend one hundred feet in length. It has been said, that when a young tree is inverted so as to have its branches buried in the earth, and its roots in the air, the leaves are changed into roots and the roots into leaves. This, however, is incorrect; the leaves are no more changed into roots than the roots into leaves. But when they are placed under the earth, the buds situated in the axilla of the leaves, instead of producing young branches, or leafy scions, are elongated, blanched, and become radical fibres, while the latent buds of the roots, which are destined annually to renew the tufts of radical fibres, being placed in the other medium are expanded into leaves. We have

also a striking example of this tendency of the latent buds of the root, to change into leafy branches when placed in the air, in those shoots which sprout up around trees, which have creeping roots, such as the acacia and poplar. The roots of certain trees, at different distances, produce a species of cones, or excrescences of a loose, soft wood, quite naked, and standing above ground, which are called *exostoses*. The cypress of North America affords an example of this.

The root is commonly divided into three parts. The body or middle part, of various forms and consistences, sometimes more or less swelled, as in the turnip and carrots. The collar or life knot, an annular bulge at the point where the stem joins the root, and from which springs the bud of the annual stem, in perennial roots. The radical or minute branching fibres, which terminate the root. Roots, according to their duration, are distinguished into biennial, perennial, and woody. Annual roots belong to those plants which, in the course of one year, come to their maturity and perish, such as wheat, cockspur, poppy, &c. Biennial roots are those of plants which require two years to come to maturity. During the first year, biennial plants usually produce nothing but leaves; in the second year they perish, after having flourished and produced fruit, as the carrot. The perennial roots are those which belong to woody plants, and to those which, during an indefinite number of years, send forth herbaceous stems, which annually flourish and decay, while the root lives for several years, such as those of asparagus, asphodils, lucern. This division of vegetables, however, into annuals, biennials, and perennials, according to the duration of their roots, is liable to vary under the influence of divers circumstances. The climate, temperature, and situation of a country, and even cultivation, influence, in a singular degree, the duration of vegetables. It is no uncommon thing to see annual plants vegetate for two years, and even more, if they are placed in a suitable soil and protected from the cold. Thus, the mignonette, which, in Europe, is only an annual plant, becomes perennial in the sandy deserts of Egypt. On the contrary, perennial, and even woody plants of Africa and America, become annuals when transplanted into northern climates. The marvel of Peru and cobœa, are perennial in Peru, and die annually in our gardens. The castor oil plant, which in Africa forms woody trees, is annual in our climate, yet it again resumes its woody character when placed in a proper exposure. In general, all perennial exotic plants, whose seeds can produce individuals that flower the first year in our climate, become annuals. This is the case with the castor oil plant, the cobœa, marvel of Peru, &c. Woody roots differ from perennial only in their more solid consistence, and in the permanency of the stems which they support, such as those of trees and shrubs. There are four principal divisions of roots: 1st, Vertical, or those which sink perpendicularly into the earth. 2d, Fibrous, or those branching out into fibres. 3d, Tuberous, having round or oval appendages. 4th, Bulbous, having a bulb at the top.

1. *Vertical roots* are those which sink perpendicularly into the earth, as the carrot, *c*, turnip, *b*,

14.

a *b* *c*

and radish. They are either simple, as in this vegetable; or branched, as in the ash, *a*. They belong exclusively to the class of Dicotyledonous vegetables. They are not true roots, however, but merely give off the fibrils, or proper roots.

15.

d

2. The *fibrous root d*, consists of a great number of fibres, which are either simple and slender, or thick and ramified. The roots of a great proportion of the palms are of this kind, and such roots are found in the Monocotyledonous class only.

3. *Tuberous roots* are those which have attached to the true root, at different points, sometimes at the upper part, sometimes in the middle or at the extremities, tubers or roundish bodies.

16.

e

(fig. 16, *e*). These tubercles or fleshy bodies, which are commonly, though erroneously, called roots, are only masses of a starchy consistence and substance, which nature has thus stored up, to afford a supply of nutritious matter for the future germ. They are more or less numerous, as in the Jerusalem artichoke and potatoe. They are never found in annual plants; but belong exclusively to perennial. Sprengel considers these tubercles as a kind of subterranean buds, to which nature has confided the preservation of the rudiments of the stem. The only difference which the tubercles, thus considered, present, is that the young stem, in place of being protected by numerous and close scales, is enveloped by a dense and fleshy body, which not only serves to protect it during winter, but supplies it in spring

with the first materials of its development and nutrition. They might equally be considered as short and fleshy subterraneous stems, and the eyes which spring from them might be viewed as buds. Or might we not rather regard them as subterraneous cotyledons, containing the germ of the future plant, and the nourishment necessary for its development.

17.

f *g*

4. *Bulbous roots* are either scaly *f*, or coated *g*. The onion is of this kind of root, and is formed of a thin flat tubercle called a disk, which, at its lower part, produces a fibrous root, and on its upper supports a bulb, which is a bud of a particular kind, formed of a number of coats or concentric layers, one above the other. From the centre of the bulb, a short or herbaceous stem is produced, which dies down. Of this kind are also the lily, hyacinth, garlic, and other bulbous plants.

Such are the principal forms which we find the roots of plants assume; yet, of these forms there are many modifications and varieties. Here, as throughout her other works, Nature does not adhere servilely to artificial or systematic divisions. She sometimes obliterates, by insensible gradations, those differences which we at first thought so complete and decided; and many of these modifications are accomplished to accommodate the plant to the nature of the circumstances amid which it is placed. Thus, the radicles or fibrils of the roots are comparatively larger, and more abundant, the looser the soil in which the vegetable lives. When the extremity of a root happens to meet a stream of water, it elongates, divides into capillary and branched fibrils, and constitutes what is called by gardeners a fox's tail. This circumstance, which may be produced at any time, shows why aquatic plants generally have much larger roots than others. All the roots which cannot be referred to any of the four divisions above enumerated, retain the general name of roots; but a few particulars may be added regarding the variety of structure, as useful to practical botanists. The root is said to be *fleshy*, when besides being manifestly thicker than the base of the stem it is at the same time more succulent, as in the carrot, turnip, &c. On the contrary, it is said to be *woody* when its structure is more solid, approaching, in some degree, to the hardness of wood. This is the case in most woody vegetables. *Simple* roots have a single tapering body entirely without divisions; a branched root is one divided into more or less numerous ramifications, always of the same nature as itself, which is the case in most of our common trees, as the oak, elm, ash. The root is *vertical* when its direction is perpendicular to the earth's centre, as the carrot, radish; *oblique*, as in the *iris;* or *horizontal*, as in the elm; not unfrequently these positions are assumed by the different radicles of one root. As to shape, roots are called *fusiform* when they are thick in the middle, and taper to both ends, as in the radish; *napiform*, as in the common turnip, Spanish radish; *conical*, with the form of a reversed cone, as in the beet, parsnip, carrot; *rounded*, as in the earth nut; *testiculate*, when it has one or two rounded egg-shaped tubercles, as in Jerusalem artichoke; in this root, one of the tubercles is firm, solid, and somewhat larger than the other; it is that which contains the rudiments of the stem which is to grow in the ensuing year; the other, on the contrary, being soft, wrinkled, and smaller, contained the germ of the stem which has been last developed, and on whose growth it expended the greater part of its amylaceous or starchy substance; *palmate*, when the tubercles of the root are divided about the middle into lobes like fingers, as in the spotted orchis, *i*.

18.

i *k*

Digitate, when this division extends nearly to the base of the root, as in some of the others of the genus orchis; *k*, *creeping*, as in mint and other familiar plants; *knotty*, when the ramification of the root presents at intervals a kind of enlargement or knots, which impart somewhat the resemblance of a necklace, as in the drop wort, fig. *l*. These knots, however, are not to be confounded with the true tubercles, which always contain the rudiments of a new stem. *Granulated*, which present a mass of small tubercles containing eyes, by which a new plant is produced, as in the *saxifrage, saxifraga granulata; fasciculate*, when formed of numerous thick, simple, or branched radicles, as in asphodel and ranunculus; *articulated*, or forming joints at regular distances, as in gratiola; *contorted*, when curved in different directions, as in bistort; *capillary*, formed of a number of slender capillary tubes, as in wheat, barley, grasses; *comose*, when the filaments are branched

19.

l

and very close, as in the heaths. The internal structure of roots very closely resembles that of the stem, and shall be described along with that organ.

According to the general laws of vegetable growth, plants of the same species are furnished with the same species of root, not producing at one time a woody or fibrous root, and at another a bulbous root. Yet some exceptions to this rule occur. If part of the root of a tree planted by a pond or river, is accidentally laid bare on the side next the water, or if in the regular course of its growth it protrudes beyond the bank, so as to be now partially immersed, the future development of the part is considerably affected; for the root, which was formerly firm and woody, instead of augmenting in the regular way by the accession of new layers between the wood and bark, thus enlarging the mass, divides now at the extremity into many ramifications, or sends out a number of fibres from the surface, which become again subdivided into fibres still more minute, and gives to the whole an appearance something like a foxe's tail, *m*. This may be seen in willows, growing beside ponds. On the other hand, the *phleum pratense*, when growing in its natural moist soil, has a fibrous root; but when in a dry soil, where it is not unfrequently found, the root is bulbous. The roots of *utricularia minor*, exhibit curious appendages of small membranous bladders attached to their slender filaments, containing a transparent fluid and a bubble of air, by means of which the plant is kept floating in the water. If a slice of the beet root be examined when the plant is a year old, it will exhibit from five to eight concentric circles of tubes or sap vessels, imbedded at regular intervals in its pulp; whereas other biennial roots form only one circle for each year, and are consequently furnished at no time with more than two.

20.

The most singular circumstance regarding roots, however, is that they may be transformed into stems, by inverting the plant. Thus, if the stem of a young plum or cherry tree, or of a willow, is taken in autumn, and bent so as that one half of the top may be laid in the earth, one half of the root being at the same time taken carefully out, but sheltered at first from the cold, and then gradually exposed to it; and the remaining part of the top and root subjected to the same process in the following year, the branches of the top will become roots, and the ramifications of the root will become branches, protruding leaves, flowers, and fruit in their season.

Use of roots. In the first place, as regards the plant itself, the use of the roots is to serve as a means of attachment to it in the soil, and to draw from thence a portion of the juices necessary for its life and nourishment. The roots of many plants appear to perform only the first of these functions. This is chiefly remarkable in thick succulent plants, which absorb from the air the substances necessary for their nutrition at all points of their surface; in this case, these roots serve simply to fix the plants to the soil. The magnificent *cactus Peruvianus*, growing in the hot house of the museum of natural history at Paris, is of an extraordinary height, and sends out its large branches with extreme vigour, and often with amazing rapidity; yet its roots are contained in a box which barely holds four cubic feet of earth, which is never renewed or watered. Some other plants of the same nature may be suspended by a thread to the ceiling, and they will grow without any earth at all, merely by absorbing their nourishment from the atmosphere. Neither are the roots of plants always in proportion to the strength or size of the trunks which they support. The tribe of palms and pines, whose trunks sometimes reach the height of a hundred feet and upwards, have very short roots, which do not extend far in the ground, and attach themselves but feebly to it. On the contrary, herbaceous plants, whose weak and slender stems die yearly, have sometimes roots of great length and size compared with the stem, as is the case in the liquorice shrub, lucern, and the common weed called rest-harrow. In general, however, roots extract from the earth the substances which contribute to the growth of the plant. All parts of the root, however, do not equally perform this office, which is accomplished chiefly, if not solely, by the extremities of the small fibres. It has been found that their extremities are terminated by little spongy bodies, called *ampullæ* or *spongioles*, with porous absorbing mouths. Dutrochet has minutely described these spongioles, which may be seen by the aid of a microscope, attached as little bags or knobs, to the minute fibres of the roots, as seen at *a a* in the wood cut. With a high magnifying power, hexagonal cells are visible, covered by a porous cuticle. The small bulb at the extremity of the root of the common duck weed, affords a good example of these spongioles. Whatever be their structure, Dutrochet thinks, absorption is performed by those extremities alone; and the truth of this may be established by a simple experiment. If we take a radish or turnip, and immerse in water the small root by which the bulb is terminated, it will vegetate and shoot forth leaves. On the contrary, if it be so placed in the water that its lower extremity is not immersed, it gives no

21.

sign of growth. The roots of certain plants appear to excrete a peculiar matter, which varies in the different species. Du Hamel mentions, that having caused some old elms to be rooted up, he found the earth about their roots of a darker and more unctuous colour than that around. This unctuous fatty matter was produced by excretion from the roots. To this matter, which varies, as we have said, in different species of plants, the sympathies and antipathies which certain vegetables have for each other is no doubt to be attributed. For it is well known, that certain plants in a manner seek one another, and live constantly near each other. Such are called social plants; while, on the contrary, others seem hurt by these peculiar matters, and will not grow near. Hence, too, the well known fact, that certain vegetables will not thrive if successively planted in the same soil. It has been remarked, that roots have a marked tendency to grow in the direction of veins of good soil; and that they are often extended considerably, in order to reach the places where the soil is richer, and more friable. They then grow with more vigour and rapidity. Du Hamel states, that wishing to protect a field of excellent soil from the roots of a row of elms which were extending in that direction, and wasting a part of it, he caused a deep trench to be sunk along the row of trees, which cut across all the roots that stretched into the field. But soon after, the new roots, on arriving at one of the sides of the ditch, curved downwards, following the slope until they arrived at its lower part, when they, proceeding horizontally under the ditch, rose again on the other side, following the opposite slope, and extended anew into the field. The roots of trees have not all the same facility of penetrating the hard subsoil. Du Hamel observed that a vine root had penetrated a very hard subsoil to a great depth, while an elm-root had been stopped by it, and had in a manner retraced its steps. We have already remarked that the root has a natural and invincible tendency to direct itself towards the centre of the earth. This tendency is especially observed in this part at the moment it begins to be developed from the seed. It is afterwards less apparent, although it always exists, especially in those roots which are simple, as in the top root of those which are branched, for it frequently does not exist in the lateral ramifications of the root. Whatever obstacles may be opposed to this natural tendency of the radicle, it possesses the power of surmounting them. Thus, if a germinating bean or pea be placed in such a manner that the seed lobes are situated in the earth, and the radicle in the air, the radicle is soon seen to bend towards the earth, and immerse itself in it. This phenomenon has given rise to much speculation, and has received various explanations. Some suppose that the root has a tendency to descend, because the fluids which it contains are less elaborated, and consequently heavier than those of the stem. But this explanation is contradicted by facts. In certain exotic vegetables, such as *elusiarosea*, we see roots forming upon the stem at a great height, and descending perpendicularly to penetrate into the ground. Now, in this case, the fluids contained in these aerial roots are of the same nature as those which circulate in the stem, and yet these roots, in place of rising like it, descend towards the earth. It is not, therefore, the difference of the weight of the fluids that gives them this tendency towards the centre of the earth. Others have imagined that they discovered the cause in the avidity of roots for moisture, which is more abundant in the earth than in the atmosphere. Du Hamel, with the view of ascertaining the truth of this explanation, made seeds germinate between two moist sponges, suspended in the air. The roots, in place of directing themselves towards either of the two sponges, which were well soaked with water, crept between them, and hung out below; thus tending towards the earth. It is not moisture, then, that attracts roots towards the earth's centre, as is partly illustrated by another experiment. Dutrochet filled a box with earth, in the bottom of which several holes were bored. In these holes he placed French beans in a state of germination, and suspended the box in the open air, at a height of about twenty feet. In this manner, the seeds, being placed in the holes formed at the lower surface of the box, received from beneath the influence of the atmosphere and light, and the moist earth was placed above them. If the humid earth be the cause which determines the direction of the radicle in this case, it ought to be seen ascending into the earth which lies above it; and the stem, on the contrary, ought to descend into the atmosphere placed below it. This, however, did not happen; the radicles of the seeds descended into the atmosphere, where they soon perished, while the plumules mounted upwards into the earth.

Mr Knight, the celebrated botanist, wished further to ascertain, by experiment, whether this downward tendency could be destroyed by a rapid circular motion communicated to germinating seeds. He accordingly fixed some seeds of French beans in the nave of a wheel, kept continually moving in a vertical plane by a stream of water, the wheel performing one hundred and fifty revolutions in a minute. The seeds, which were placed in some moss, kept constantly moistened, soon began to germinate. All the radicles were directed towards the circumference of the wheel, and all the gemmules towards its centre. By each of these directions, the gemmules and radicles obeyed their natural and opposite tendencies. The same gentleman made

a similar experiment with a wheel, moving horizontally, at the rate of one hundred and fifty revolutions in the minute. The results were similar, that is to say, all the radicles were directed towards the circumference, and the gemmules towards the centre; but with an inclination of ten degrees of the former towards the earth, and of the latter towards the atmosphere. These experiments were repeated by Dutrochet, and with the same results, except that in the second the inclination was not so considerable, and that the radicles and gemmules were nearly horizontal. From these experiments, many have concluded that the roots, in their descent, merely obey the common laws of gravity. Before this conclusion could be made, however, the phenomena of the gemmules ascending into the air, contrary to the laws of gravity, ought to be also explained. "But," says, Mr Keith, "if gravitation acts so very powerfully upon the radicle, why will it not condescend to exert its influence upon the gemmules also, which, if not so heavy as the radicle, are at least specifically heavier than atmospheric air; and why does it make an exception in favour of some radicles." He then instances the case of the misletoe. This singular plant shoots out its radicle in whatever situation chance may place it. Thus, when the seed, which is enveloped in a thick and viscid glue, adheres to the upper part of a branch, its radicle, which is a kind of hollow tubercle in the shape of a horn, is then perpendicular to the horizon. If, on the contrary, the seed be applied to the under surfaces of the branch, the radicle will be directed towards the heavens; or if situated on the lateral surfaces, the radicle will be directed laterally. In short, in whatever situation the seed may be placed upon the branch, the radicle will always assume a direction perpendicular to its axis. Dutrochet tried numerous experiments on the germination of this seed, in order to ascertain the laws of determination of its radicle. This seed, which finds in the viscid substance that surrounds it, the first materials of its growth, germinates, and is developed, not only on wood, either living or dead, but also on stone, glass, or iron. Dutrochet caused it to germinate on a cannon ball. In all these cases, the radicle was invariably directed towards the centre of those bodies. The same experimenter fastened a germinating seed of misletoe to one end of a copper needle, moving on a pivot like that of a mariner's compass, a small bit of wax being placed at the opposite end, to serve as a counterpoise to the seed. Matters being thus arranged, he placed, in a lateral direction to the radicle, a pin of wood, so as to be at the distance of nearly half a line. The whole was covered with a glass receiver, so as to guard against disturbance from external causes. After the lapse of five days, the stem of the embryo was bent, and its radicle directed towards the small plate that was near it, without any change being produced in the position of the needle, notwithstanding its extreme mobility on the pivot. Two days after, the radicle was directed perpendicularly towards the plate with which it came in contact without producing the slightest derangement of the needle that bore the seed. The radicle of this seed exhibits another constant tendency, which is that of avoiding light. If the seeds are made to germinate in the inner side of the glass of a window, the radicles are all directed to the interior of the apartment in search of darkness. If a seed be stuck on the outside of the glass, the radicles closely adhere to it, impelled by its tendencies inwards to shun the light. These, and other facts, then, present unsurmountable objections to the theory of mere mechanical attraction. "If," says Mr Keith, "I were to offer a conjecture in addition to the many that have been already formed, I should say that the invincible tendency of the radicle to fix itself in the earth, or other proper soil, and of the gemmule to ascend into the air, arises from a power inherent in the vegetable subject, analogous to what we call instinct (or, perhaps, he should have said the vital impulse) in the animal, infallibly directing it to the situation best suited to the acquisition of nutriment, and consequent developement of its parts. And upon this hypothesis, we include all varieties of plants whatever, parasitical as well as others. For let them attach themselves to whatever substance they will, to them it still affords a fit and proper soil." Something more than mechanical attraction is evident also in the tendrils of climbing plants; one species uniformly twisting to the right, while another as constantly twists to the left. The explanation of Dutrochet's theory of the ascent of sap, to be given afterwards, will perhaps tend to throw some light on this curious subject.

Economical uses of roots. Many roots are usefully employed in domestic economy, as articles of food. Such are the well known roots of carrots, turnips, parsnips. These have been greatly increased in size by cultivation, so much so as scarcely to be known to be the same as the original species growing wild. From the tubercles of the orchis tribe, salop is manufactured; sugar is got from beet root, of a quality little inferior to that obtained from the cane. Roots are more generally odorous than the stems of plants, which is owing to an essential oil. Thus, ginger, horse radish, valerian, spignel, and sweet cicely, are pungent and aromatic; the root of white hellebore is bitter and nauseous. Other roots again are sweet, bland, and mucilaginous, as liquorice root, beet, carrot, &c. Some roots are used for dyeing, as madder, alkanet, turmeric; other roots are medicinal, as rhubarb, ipeca-

cuan, jalap. The peculiar properties of roots, however, shall be more fully described under the heads of the particular plants used for domestic and economical purposes. Certain plants which have the power of shooting out roots that ramify and extend to great distances, are used for the purpose of consolidating sandy and movable soils. Thus, in Holland, and around Bourdeaux, the *carex arenaria* is planted on the downs, and on the banks of canals, for the purpose of fixing and consolidating the soil; and the sallow thorn, and Spanish broom, are used in many other countries for similar purposes.

CHAP. VI.

THE STEM.

As the root tends towards the earth, so the stem is that part of the plant which mounts into the atmosphere, and besides giving support, and the means of attachment, to leaves, blossoms and fruit, it contains also the vessels which convey the sap from the root upwards. Some of the simpler plants have no stem, as the lichens; others have a soft herbaceous mass, in which are combined stem, branches, and leaves, as the duck weed or *lemna*, already alluded to, the *cactus*, &c. In the fungi, the nature of the stem *a b*, is simple, and composed of the same cellular membrane as the other parts of the plant.

22

All the phanerogamous, or flowering vegetables, have a proper stem, but this stem, in many species, is so small as to be occasionally overlooked; of this kind are the primrose and hyacinth, the leaves of these plants appearing as if they sprung directly from the summit of the root. In these last mentioned plants, and many others, there is a stem which shoots up, and bears the flowers and seed; this is called the *scape*, and is not to be confounded with the true stem. Sometimes this flower stalk springs from a part of the leaf of the plant, when it is called the *radicle peduncle*, as in the plantain. There are several kinds of stems, which we shall proceed to notice.

The trunk is the central and supporting part of trees, as the oak, ash, fir. Its largest diameter is at the root, and it tapers gradually as it ascends, assuming somewhat of a conical form. For a space below, it is single and naked, but as it approaches the top it divides and subdivides into numerous ramifications; on these branches, twigs, and ramuli, are situated the leaves, blossoms, fruits, seeds. The trunk is peculiar to dicotyledonous trees; internally, it is made up of successive circles of woody matter, disposed one inside the other in concentric layers, and increases in height and breadth by the addition of new layers, formed one outside the other like a succession of cones.

The stipe is the stem of the monocotyledonous class of trees, such as the palms and yuccæ, and a few of the dicotyledonous, as the cycas and zamia. It is a cylinder of equal thickness from top to bottom, sometimes even swelling out in the middle or the top, with no branches, but crowned at the summit by a tuft of leaves and flowers. Its bark differs little in structure from the stem. It increases in height by the successive growths of the bud at the top, and in breadth by the multiplication of its filaments. Internally, its structure also differs from that of the dicotyledonous trunks.

The culm, or straw, is the supporting stem of the grains, grasses, reeds, and canes. It is a simple or single stem, rarely branched, most commonly hollow within; and having at intervals knots or compressed parts, which give it strength and solidity, and from which proceed alternate leaves.

The stock or rhizoma, or stem root, as it has been called, is found in a considerable number of plants. It is partly or entirely concealed under ground, is irregularly knotted, and sends off new stems from its anterior part, as the others decay. Of this kind, are the stems of the iris, scabiosa, anemone, and Solomon's seal. See wood Cut. Besides, its nearly horizontal direction under ground, one of the principal characters of the stock, and by which it is distinguished from the root, is that it always, in some part of its extent, presents traces of the leaves of preceding years, or scales which take place of them, and that it increases by its base, or the part nearest the leaves which is the reverse of what takes places in the true root.

The general name of *stem* is given to all those varieties which do not strictly come under any of the above descriptions; and it may be remarked, that the number of vegetables that have a proper stem, is much greater than that of those with a stipe, or culm, or trunk. The practical Botanist distinguishes the varieties of the stem thus:—

Herbaceous, green, tender, and lasting for a single year; as borage, chickweed, camfrey, &c. All these rank under the name of *herbs*.

Semiligneous, half woody, hard, and continues above ground for several years, while the slender twigs and branches are removed annually; as common rue, garden thyme, sage.

Woody (ligneous) stem, hard, solid, enduring for years; divided into two classes. *Shrubs*, which send out branches from the base or root,

and are destitute of buds; as the heaths. *Trees*, having trunk branches, buds.

Solid, when the stem has no internal cavity; as most trees, the sugar cane.

Fistulous, or hollow, with an internal canal, either continuous or divided by partition, at intervals; as in grains, grasses, bamboo cane, &c.

Pithy, or medullary, fitted with a large pith; as in the elder.

Soft, when it is unable to support the erect position, and falls to the ground. *Firm, flexible, brittle, succulent*, are other terms which sufficiently explain themselves.

In shape, the stem may be cylindrical, compressed, angled, knotty, jointed, geniculated, or bent at the joints in the form of the knee, climbing, when it coils round other stems.

Sarmentaceous, when it ascends trees, or other bodies, by means of tendrils or other peculiar appendages.

Simple, without ramifications, as in the foxglove, white mullein.

Branched, divided into branches and twigs.

Dichotomous, dividing into two forked branches on bifurcations. *Trichotomous*, into three.

Vertical, stem growing erect.

Prostrate, or procumbent, when it lies on the ground.

Creeping, when it trails on the ground, taking root at certain joints.

Tortuous, forming curves in different directions.

Spiral, curving in a regular screw form.

Leaf-bearing, having leaves; *leafless*, the reverse.

Scaly, having leaves placed in the form of scales.

The stem may be either smooth or dotted, hairy, glaucous or powdery, spinous or thorny, prickly.

Internal form of stems. The structure of stems proceeding from a two lobed (or dicotyledonous) seed, differs considerably from those growing from a one lobed or monocotyledonous seed; hence, the two first great divisions of the vegetable kingdom already alluded to. We shall proceed first to describe the dicotyledonous stems.

When we examine a piece of the trunk of a tree, such as the oak or elm, we find it composed of the following parts.

In the centre is the pith or medulla, *a;* then the solid woody mass of the trunk, in successive circles, from the central pith outwards. The outer woody circle of newest formed wood or *alburnum, b.* Immediately investing this, the *liber* or inner bark, *c;* between the inner bark, *c*, and the epidermis or outer skin, *d*, is a soft green juicy matter, called the *herbaceous* envelope and cortical layers, *e*.

23

The *epidermis, cuticle*, or outer skin, is a part common to all organized beings both of the vegetable and animal kingdom. In vegetables it is a thin, nearly transparent layer, formed of a uniform tissue, which appears composed of cellules varying extremely in form, and presenting numerous small openings or pores, which some authors consider as a kind of inhaling mouths. The epidermis envelopes all parts of the vegetable; but it is more especially apparent on young stems, from which it may easily be separated with a little caution. It possesses only a certain degree of extensibility, and when stretched beyond this point, by the enlargement of the trunk, it tears and splits, as is observed in the oak and elm, or it is detached in flakes or plates, as in the birch and plane. When removed from a young stem, it is reproduced without difficulty. It is the part of the vegetable that resists decomposition longest, and putrefaction has no perceptible action upon it. The colour which it presents is not inherent in its nature, but is derived from the peculiar colouring of the tissue on which it is applied. Hence the green colour so prevalent in the leaf and tender shoot, which the transparent epidermis merely transmits, and the beautiful variety of lines displayed in flowers and fruits. And yet the colour is sometimes inherent, even in the epidermis itself, as may be seen by inspecting that of the lower part of the petals of the crocus. In the permanent parts of woody and perennial plants, the old epidermis often disengages itself spontaneously, as in the currant, birch, and plane tree; in which it seems to be undergoing a continued waste and repair, and in such parts it is again regenerated, even though destroyed by accident. But in herbaceous plants, and in the leaf, flower, and fruit of other plants, it never disengages itself spontaneously, and is never again regenerated, if once destroyed.

The nature and origin of the epidermis form two rather obscure subjects in vegetable anatomy. Some authors say, with Malpighi, that the epidermis is not a membrane distinct from the rest of the vegetable tissue. They consider it as formed by the outer wall of the subjacent cellules, belonging to the herbaceous tissue, hardened by the continued action of the air and light. Others, again, concur with Grew in considering it as a perfectly distinct membrane, simply applied upon the subjacent cellular tissue. The microscopic observations of Professor Amici throw much light on this question, and seem to confirm the second of these opinions According to that naturalist, the epidermis is a membrane entirely distinct from the cellular tissue upon which it is applied. And in this respect, it closely resembles the outer skin of

animals. When examined with the microscope, it is seen to be composed of a single layer of cellules, whose form varies exceedingly in different plants. It is this cellular structure that has led into error the authors who have thought the epidermis to be formed of the outer wall of the cellular tissue. But, were this the case, the cellules which constitute the epidermis would always have the same form as the subjacent tissue, which, however, they are found not to have. Thus, in the pink, the cellules of the epidermis have a four-sided form, while the immediately subjacent layer consists of a multitude of tubes perpendicular to the epidermis. The same occurs in many other vegetables; from which it may be concluded that the epidermis is a cellular membrane, entirely distinct from the subjacent tissue, upon which it is merely applied.

The epidermis presents numerous small openings, named *cortical pores*, *cortical glands*, *epidermic glands*, and lastly, *stomata*. Several authors have denied their existence; but Amici, by the aid of the microscope, has seen them in a great number of vegetables, and has described and figured them with the greatest accuracy. They are a kind of small bags, situated in the substance of the epidermis, and opening externally by a slit or elongated oval aperture, bordered with a kind of rim formed by particular cellules of the epidermis. This rim, or thickened margin, which is very seldom wanting, possesses the power of contracting or dilating the aperture according to circumstances. They are here represented as seen in the leaves, *a b*.

24

Thus, humidity or water closes the pores, while drought, and the action of the solar rays, keep them open, and separate their margins. The motions of dilatation and contraction are not confined to the living plant alone, but also take place in detached fragments of the epidermis. These pores or little bags always correspond by their base to spaces filled with air only, and resulting from the arrangement of the cellules or tubes with respect to each other. These intercellular spaces almost always communicate with each other, and thus afford a means of communication to the aëriform fluids which exist in the interior of vegetables. Some parts, however, as the roots, the petioles which are not leafy, the petals in general, the epidermis of old stems, and that of fleshy fruits and seeds, appear to be destitute of stomata. Certain leaves have them only on one of their surfaces, while others have them on both.

Various conjectures have been formed regarding the use of these curious pores. They cannot be destined for the absorption of moisture, for we have already seen that they correspond to internal spaces which are destitute of juices, that they are closed by water, and that light and drought cause them to open. Moreover, they are wanting in all roots, as well as in plants that live constantly under water. They do not therefore serve for the absorption of water. Nor are they intended for evaporation; for if we allow a plant which has been detached from its roots to die, although the pores close after some time, evaporation still continues, so long as any fluid remains in its interior. It has been observed, moreover, that the corollas and fruits, which are destitute of cortical pores, yet produce an abundant evaporation. M. Link supposed them to be excretory organs, but this cannot be the case, as they always correspond to empty spaces. The real office of the cortical pores seems to be to give passage to air. But it is not easy to determine with certainty whether they serve for inspiration more than expiration, or for both these functions alike. If we consider that at night, when the large pores of the epidermis are closed, leaves absorb carbonic acid gas dissolved in the dew, which undoubtedly penetrates into the cellules by passing through their membrane; and if we reflect, moreover, that these leaves decompose carbonic acid gas, when the pores are open, that is, during the day, we may suppose them to be solely destined for the exhalation of oxygen. This use becomes still more probable, when we add that the corollas which, according to Decandolle's observations, are destitute of pores, are equally destitute of the faculty of disengaging oxygen.

The surface of the epidermis sometimes presents certain organs named *lenticular glands*, or *lenticelles*, which appear under the form of small spots elongated in the longitudinal direction in young branches, and in the transverse direction in older branches. No traces of them have yet been discovered in the monocotyledonous or acotyledonous plants. They are also wanting in the herbaceous plants of the dicotyledonous class. They are very distinct on the epidermis of the birch, and especially on that of *euonymus verrucosus*, where they are very prominent and close. From these lenticelles spring the roots which certain trees develope upon their stem, or those which form when a branch is immersed in the ground, as in the operation of propagating by layers. They may therefore, in some measure, be considered as root-buds.

From the surface of the cuticle also spring the hairs of various kinds which are observed on many plants.

The herbaceous envelope. Under the epidermis is observed a layer of cellular tissue, connecting the former with the cortical layers, and

named the *herbaceous envelope*. Its colour is generally green in young stems. It covers the trunk, the branches and their divisions, and fills up the spaces which exist between the ramifications of the nerves of the leaves. To this, Dutrochet applies the name of the *outer medulla*, in opposition to that of *inner medulla*, which he gives to the pith. Its colour is not derived from the cellular tissue of which it is composed, but is owing to the small grains of globuline, situated in the walls of the cellules, and which Dutrochet considers as nervous corpuscules.

The herbaceous envelope, or outer medulla, frequently contains the proper juices of vegetables, which are enclosed in particular canals or reservoirs. It is readily repaired on the stem of woody vegetables; but this phenomenon does not take place in annual plants. It appears to have an organization and uses similar to those of the pith contained in the medullary tube. When this herbaceous envelope acquires great thickness, and peculiar physical qualities, it constitutes the part known by the name of cork in the cork tree, (*quercus suber*) and some other plants. The herbaceous envelope is the seat of one of the most remarkable chemical phenomena which vegetable life presents: in its interior, and that by a cause which it is difficult to understand, the decomposition of the carbonic acid absorbed from the air by the plant, is effected, the carbon remaining in the interior of the vegetable, while the oxygen that has been disengaged is thrown out. It is to be remarked, however, that this decomposition takes place only when the plant is exposed to the rays of the sun, whereas the carbonic acid is thrown out undecomposed when the vegetable is withdrawn from the influence of that luminary. This organ is partly renewed each year. It also performs a very important part in the process of vegetation. At the return of summer, it incites the sap to ascend towards the buds, and thus becomes one of the most powerful agents in producing their growth and development into leaves.

The herbaceous envelope is very easily discovered on the young branches of a tree, it being the part exposed when the epidermis is removed.

The *cortical layers*, or *outer bark*, do not always exist, and are occasionally so slightly developed, and so little distinct from the liber, that it becomes very difficult to recognise them. They are placed beneath the herbaceous envelope, and are applied upon the outermost layers of the liber, from which they can hardly be distinguished. In no vegetable are they more apparent, or more remarkable for the singular disposition of the tissue of which they are composed, than in the lace-tree, in which they form several layers above each other, which, on being stretched out, bear a perfect resemblance to some kinds of linen, or represent lacework of pretty regular texture. In most plants, however, it is difficult to distinguish this part from the liber.

The *liber*, or *inner bark*, or true bark, as it is sometimes called, lies immediately in contact with the alburnum, or first circle of woody fibre. It is composed of a vascular network, the elongated meshes of which are filled with cellular tissue. It is seldom that it can be easily separated into distinct laminæ, or plates, which have been compared to the leaves of a book,* but this effect may almost always be obtained by maceration.

The different laminæ of which the liber is composed, and which have been successively formed, have thin layers of cellular tissue interposed between them. When the liber is macerated, this cellular tissue is destroyed, and allows the laminæ to be separated.

Like all other parts of the bark, the liber is capable of being replaced when it has been removed. Before it can be reproduced, however, the part from which it has been detached must be guarded from the contact of air. This important fact we owe to Du Hamel. That excellent naturalist, to whom vegetable physiology is indebted for so many happy discoveries, removed a portion of bark from a vigorous tree in full vegetation. He secured the wound against the contact of air, and presently saw exuding from the surface of the woody body, and the edges of the bark, a viscid substance, which, spreading over the wound, acquired consistence, became green and cellular, and reproduced the portion of liber that had been removed.

To this viscid substance, which exudes from the denuded parts to reproduce the liber, Grew, and after him Du Hamel, gave the name of *cambium*. Several authors are of opinion that the cambium is nothing else than the descending and elaborated sap. This opinion becomes the more probable, when we reflect that this viscid fluid performs exactly the same functions in the animal economy as those generally attributed to the descending sap, which is conveyed bv the same parts.

Whatever be the origin of the cambium, it performs a very important part in the growth of the stem. For, in all the theories that have been advanced with the view of explaining that phenomenon, its presence is indispensable, as we shall presently show, when we come to treat of the growth of dicotyledonous stems.

Numerous experiments prove that the liber is absolutely necessary for vegetation. A graft does not succeed unless its liber be in contact with that of the tree on which it is inserted; and a slip, whose lower part is destitute of liber,

* Before the manufacture of paper, the inner bark of some trees was used as a substitute; hence, the derivation of *liber*, a book.

does not take root. If a circular band of liber be removed from the trunk of a tree, in such a manner as to leave the woody body exposed, not only will all the parts of the tree above this band cease to be developed the following year, but the entire tree will ultimately perish. This process, called girdling, the Americans have recourse to in clearing their forests.

The liber is hardened each year, and new layers are formed at its inner surface, by means of the cambium.

Alburnum or false wood. The outermost woody layers, or those which are in contact with the liber, constitute the *alburnum*. This substance is not distinct from the wood properly so called, the layers of which are situated beneath it. It is wood, but wood in a young state, and not yet possessed of all the hardness and tenacity which it is ultimately to present. Accordingly, the alburnum exhibits precisely the same structure as the wood, although its tissue is formed of fibres that are weaker, more distant from each other, and generally of a paler tint.

The difference of colour between the wood and alburnum is very remarkable in trees whose wood is very hard and compact, and especially in those in which it is more or less of a deep colour. Thus in ebony and logwood, the wood properly so called is black or deep red, while the layers of alburnum are of very light grayish tint. But in trees which have white and coarse-grained wood, the difference between the woody layers and alburnum is very slight.

The wood derives its origin from the innermost layers of the alburnum, which become successively harder, and are ultimately converted into true wood. The latter is therefore composed of all the circular layers situated between the alburnum and the medullary tube. At a certain period in the life of the vegetable, there are formed each year a layer of wood and a layer of alburnum; in other words, the innermost layer of the alburnum is converted into wood in proportion as a new layer of alburnum is produced at the outside, so that every year a new concentric band is added to those previously existing.

The wood is generally the hardest part of the trunk; but its hardness is not the same in all the layers of which it is composed. In dicotyledonous trees, the innermost layers, which are also the oldest, are more solid and more compact than the outer, which generally approach the alburnum in these respects. The transition from wood to alburnum is, in most cases, hardly perceptible, their colour being commonly the same; but sometimes the difference is very decided, as we have already remarked with reference to ebony and logwood.

A not less remarkable difference between wood and alburnum exists in the circumstance that the latter is entirely destitute of vessels, while they are distinctly perceived in the wood. The vessels of the wood are false tracheæ and porous vessels, but never true tracheæ or true spiral vessels. By means of these tubes, which are sometimes dispersed without order in the substance of the wood, and sometimes collected into bundles, the sap is conveyed into the substance of the trunk. But a period arrives when, through the progress of age, the walls of these vessels become thickened, their cavity diminishes, and at length even disappears, and the course of the fluids is for ever arrested in the woody substance.

Du Hamel very clearly demonstrated the transformation of the alburnum into wood. He passed a silver wire into the layers of alburnum, brought its two extremities out, and tied them. Some years after, having cut the branch, and examined the wires which he had passed into the alburnum, he found them embedded in the wood, which proved that the alburnum had been converted into wood.

The *medullary tube* occupies the centre of the stem, lining the innermost layer of the wood, and containing the pith. Its walls are formed of very long parallel vessels, longitudinally disposed. These vessels are tracheæ, false tracheæ, and porous vessels. The form of this tube varies considerably in different plants, being frequently roundish in its transverse section, sometimes oval, compressed, or with three, four, five, or more angles. Its form appears to be determined by the position of the leaves upon the branches; thus, when the leaves are opposite, the transverse section of the medullary canal is elliptical, as in the ash; if they are verticillate in threes, it is triangular, as in the rose-bay, and so forth. This law, however, presents numerous exceptions; as the *hortensia*, which with opposite leaves, has a regular hexagonal medullary tube.

The medullary tube, once formed, never changes its figure and dimensions, but remains the same during the whole life of the vegetable. It is therefore erroneous to say that it gradually contracts upon itself, and at length disappears, as the plant grows old.

The *pith* or *inner medulla*, is the loose, transparent, light, and spongy substance, formed almost entirely of cellular tissue, in its most simple state, which fills the medullary tube. A few vessels seem to run through it in the longitudinal direction. Its cellules are generally very regular. Like those of the cellular tissue in other parts, they all communicate with each other. Sometimes, and especially in young branches and herbaceous plants, the cellular tissue of the pith is abundantly supplied with fluids, and filled with granulations of a green colour, as may be

seen on breaking a branch of elder, one year old, in which the pith presents the appearance of a green and very moist fleshy body. But, in the progress of vegetation, all these substances, which are in a manner foreign to the proper nature of the pith, disappear, and there remains in the medullary tube nothing but a transparent tissue.

In some vegetables, as the stem grows, the medullary canal becomes in part, and sometimes altogether, empty, the whole pith finally disappears, and the stem becomes hollow or fistulous. This is observed in many plants of the family of Umbelliferæ.

The pith communicates with the cellular and herbaceous layer of the bark by means of peculiar prolongations, which it sends through the woody body. To these prolongations, which are disposed in a transverse section of the trunk, like rays diverging from the centre to the circumference, the names of *insertions*, *medullary prolongations*, or *medullary rays*, have been given; see Plate I. fig. 2. They establish a direct communication between the pith and the external cellular tissue of the stem.

The medullary rays are also to be found, in the greater part, of the thickness of the bark, since they serve to establish a communication between the internal medulla and the external medulla; but those of the bark have not a direct communication with those of the woody layers. Professor Amici has found them to be formed of small porous tubes, transversely placed, containing nothing but air, and establishing a communication between the internal and external parts of the plant.

Various opinions have been formed regarding the use of the pith. According to the celebrated Hales, it is the essential organ of vegetation. Being elastic and dilatable, it acts like a spring upon the other parts, which it thus urges onwards in their developement. Others, again, consider it as a totally inert body. Dutrochet revived the opinion of Hales, and makes the pith perform a very important part in the phenomena of the growth of vegetables. These opinions will be considered afterwards.

Such are the various organs which we find on analyzing the stem of dicotyledonous vegetables. All these parts, however, are far from being, in every case, united and visible in the same plant. Sometimes they are so confounded with each other, that it is impossible to distinguish and separate them. But, when the most complicated structure of a part is known, it becomes easy to imagine the organs which, in certain cases, may happen to be wanting.

Monocotyledonous stems. In general, the stem of the monocotyledones is more lengthened and more simple than that of the dicotyledonous trees. It is very seldom that it divides into branches, like that which we have just examined. The stipe of a monocotyledonous tree, as the palm, when cut across, does not, like the trunk of an oak, an elm, or any other of our forest trees, present a regular and symmetrical aspect, arising from circular zones of wood, alburnum, liber, and bark, always disposed in the same order, and a medullary canal, always occupying the central part of the stem. Here all these parts seem united, or rather confounded together. The pith fills up the whole diameter of the stem; the wood, disposed in longitudinal fasciculi, is scarcely distinguishable in the midst of the medullary substance. The bark does not always exist; and, when present, it is so little distinct from the other parts of the stem, that its use as an external covering is not apparent. In the dicotyledonous trees, the hardest part is that which is nearest the centre of the stem, because it is formed of the oldest woody layers. The reverse is the case in the monocotyledonous trees, the part nearest the circumference being found in them to possess the greatest solidity. In the dicotyledonous trees, the oldest layers are at the centre; while, in the other class, they occupy the circumference. This will be easily understood, when we shall have explained the peculiar manner in which the stem of the monocotyledonous trees grows. The fibrous bundles of the stem, which frequently unite together by their lateral parts, so as to form a more or less regular network, are, as in the dicotyledones, accompanied by porous vessels, tracheæ, and false tracheæ, destined to convey the sap, and other nutritious fluids, to all parts of the stem.

The monocotyledonous trees are therefore distinguished from the dicotyledonous not only by the structure of their seeds, but also by that of their stem. The latter, which is generally simple and cylindrical, does not, like the trunk of the oak and elm, present layers of wood enclosing each other, and disposed regularly around a central canal containing the pith; but the pith forms the whole thickness of the trunk; and the woody fibres, instead of being collected and brought close to each other, are separated, and have their bundles scattered in the midst of the spongy substance of the pith.

In Plate I. are represented magnified views of sections of different kinds of wood. Fig. 1, represents a portion of a thin, transverse slice, taken from a monocotyledonous plant; the *sugar cane*. Here there is no appearance of pith, but a uniform cellular mass from the centre to the circumference; larger openings are seen regularly interspersed among the smaller ones. In the pine tribe, including all the species of firs, junipers, yew, &c., a vertical section, fig. 2, exhibits a regular net work of hexagonal cells; in the centre is the pith or medulla, *a*, the lines *b b*, represent the medullary rays, formed

of condensed, fibrous tissue, and proceeding from the central pith to the liber or inner bark. At *c c*, are seen other lines of concentrated fibrous tissue, forming part of concentric circles, which commence near the centre, and follow each other at intervals to the circumference. These are the annular layers, and mark out the growth of each successive year. A few large openings, or lacunæ, are seen interspersed through the general structure of hexagonal cells. Fig. 3, is a vertical section of the oak, affording a specimen of the true dicotyledonous class. Here there is the central pith *a*, medullary layers *b b*, the annular layers *c c*, the alburnum *d*, liber *e*, and epidermis *f*. The small hexagonal cells are also here present; but a number of larger oval openings are also irregularly dispersed through the whole. Figs. 4, 5, 6, are vertical sections of the fir; fig. 4, is a vertical section made at right angles to the medullary rays, and exhibits a number of oval disks, or lateral sections of the cellular tubes; fig. 5, is a section of the same tree, made parallel to the medullary rays. Fig. 7, is a transverse section of the sugar cane, highly magnified; fig. 8, a transverse section of the oak; fig. 9, a transverse section of the elm.

Now that the internal structure of the different kinds of stem is known, it will be more easy for us to examine that which the roots present. The roots are generally organized like the stems. Thus, in dicotyledonous trees, a transverse section of the roots presents concentric zones of wood disposed in a circular form, and enclosed one within the other. It has been said that the best distinction between the stem and the root, is found in the circumstance that the latter is destitute of a medullary canal; while, on the contrary, it is known that it always exists in dicotyledonous trees. From this it necessarily follows, that the medullary insertions are also wanting in the roots.

This difference, however, appears of little importance, and even entirely at variance with facts. Indeed, it will be found, in a great number of vegetables, that the medullary canal of the stem is prolonged without any interruption, into the body of the root. If the stem and root of a horse-chestnut, of two years old, be split in the longitudinal direction, the medullary canal of the stem will be seen extending to the lowest part of the root. We find the same appearances in the young plant of the sycamore or maple. But very frequently, the medullary canal, which was very distinct in the plant soon after germination, gradually diminishes, and at last disappears as vegetation goes on; so that, in the root of the adult plant, it is no longer to be seen. Consequently we cannot assume as a distinctive anatomical character between the stem and the root, the want of a medullary canal in the latter, since it almost always exists in the radicle of the germinating seed, and often in the root of many vegetables, long after the first period of their life. The tapering roots, however, even those which are the largest, never present it in their ramifications.

Until lately, the want of tracheæ in the root had been considered as affording a distinctive character between the anatomical structure of the root and that of the stem; but two of the German naturalists who have made the most important observations in vegetable anatomy, Link and Treviranus, have found these vessels in the root of certain plants; and still more recently, M. Amici has unrolled tracheæ in the roots of several.

The difference which we have seen to exist in the organization of the trunk of the dicotyledones, and of the stipe of the monocotyledones, is equally observed in their roots. In fact, in the monocotyledones, a vertical root is never found forming a continuation of the stem. This disposition is a consequence of the mode in which the seed is developed at the period of germination, since, as we shall see more particularly when we speak of that function, the central and principal radicle is always destroyed soon after germination.

There is another very remarkable difference between roots and stems. The latter, in general, grow in height by every portion of their extent, while the roots lengthen at their extremity only. This was demonstrated by Du Hamel's experiments. If little marks at the distance of an inch, are made in a young stem, at the moment of its developement, it will be seen, when the growth is terminated, that the spaces between these marks have been greatly enlarged. If the experiment be repeated on the roots, it will be found that the spaces remain unaltered, while the root itself has been lengthened. which proves that the increase in length has taken place by its extremity only.

The branches, in their mode of growth, exhibit nearly the same appearances as the trunk from which they proceed. They originate in a bud, and form also a cone that consists of pith, wood, and bark, or rather, they form a double cone. For the insertion of the branch into the trunk resembles also a cone, whose base is at the circumference, and whose apex is at the centre; at least, if it is formed in the first year of the plant's growth, on the shoot of the present year; but falling short of the centre in proportion to the lateness of its formation, and number of intervening layers. Like the trunk and root, it increases also in width by the accession of new layers, and in length by the addition of new shoots, at least in as much as regards its external portion; exhibiting, however, some slight peculiarities, in as far as regards its insertion. The apex being never carried nearer to the centre

than at the period of its first formation, and the inserted portion elongating only in consequence of the accumulation of the new layers, by which the diameter of the trunk is increased. In its width, however, it increases like the external portion, by the addition of new layers pervading the alburnum of the trunk, to which it is intimately united by the intermixture of their respective fibres, forming a firm and compact knot; this may be seen by cutting across a fir tree immediately above or below a branch; for the branches are not formed merely by means of a horizontal extension of the longitudinal tubes of the trunk, but are each as it were a distinct individual, of which the external cone is the trunk, and the internal cone the root. Hence, the trunk is to the branches what the soil is to the plant, the source of its nourishment and stability. The branches of trees assume almost all varieties of position, from the reflected to the horizontal and upright; but the lower branches of trees are said to be generally parallel to the surface of the soil on which they grow, even though that surface should be the sloping side of a hill, owing, as it has been thought, to the growth of a greater number of buds on the side that forms the obtuse angle with the soil, in consequence of its being exposed to the action of a greater mass of air.

CHAP. VII.

GROWTH OF THE STEM.

All vegetables grow in diameter. It is sufficient to cast our eyes on the trees which vegetate around us, to be convinced of this truth; nor has any person ever denied it. But by what mechanism is this growth effected? On this point there is the greatest disagreement. Of the different opinions which have been advanced by physiologists, we shall select the three most important, which are these:—1. Growth is effected by the annual transformation of liber into alburnum; 2. By the development of buds; 3. By the cambium, which every year forms a distinct layer of liber and alburnum. In the first place, it has been stated that the growth in diameter is effected, in dicotyledonous trees, by the annual transformation of the liber into alburnum, of the alburnum into wood, and by the successive renewal of the liber. Such is the foundation of Du Hamel's theory, which that celebrated author has given at length in his natural history of trees.

We shall take the stem at the period of its first development, that is when, in consequence of germination, it emerges from the seed which contained it, and begins to appear externally.

All parts of the vegetable that are contained in the seed, previous to germination, are formed exclusively of a dense and regular cellular tissue. The stem, like the other organs, is found to be entirely destitute of vessels. Properly speaking, there are perceived no traces of bark, pith, liber, &c. But scarcely has germination commenced—scarcely has the stem begun to shoot up, when we see tracheæ, false tracheæ, and porous vessels forming, and by their union constituting the walls of the medullary tube. This internal part of the stem is the first that is apparent and becomes organized. The pith is contained within it; but it is as yet green, and filled with watery fluids. The outer surface of the medullary tube is soon observed to become covered with a fluid cellular tissue. This is the first layer of cambium, which, on the one hand, forms the first liber, and, on the other, constitutes the cortical layers. This liber is presently to be converted into alburnum, in proportion as a new layer becomes organized to replace the first. The following year, the new liber forms a second zone of alburnum, and thus successively, each year, a layer of alburnum is converted into true wood, while the liber itself acquires the properties and nature of alburnum. This regular development of the stem explains the formation of the concentric layers or zones, which are observed on a transverse section of the stem of a dicotyledonous tree. But these layers are not all of the same thickness, and frequently the thickness is not equal in the whole circumference of the same layer. An attentive observation easily explains this singular disposition. It has been remarked, that the greatest thickness of the woody layers always corresponds to the side on which the largest roots are found, and which have consequently extracted a more abundant nutriment from the earth. Thus, trees that are situated on the edge of a wood always have thicker woody layers on their outer side, because the roots, meeting no obstacles, extend themselves farther in that direction than in any other, and acquire a larger size.

In this theory of Du Hamel's, we see that the liber performs the most important part in the formation of the woody layers, it being each successive year converted into a new layer of alburnum, which is added to those previously existing.

The liber being the essential organ of vegetation, and changing its form and consistence each year, it was necessary that nature should also have provided means for reproducing it annually. This, in fact, is the case. If we examine attentively the successive development of the different organs which compose the stem of the dicotyledones, we see that in the first year, a gelatinous fluid, to which Grew and Du Hamel have given the name of *cambium*, occurs between

the cortical layers and the medullary tube. This peculiar fluid contains the first rudiments of organization. In proportion as the young stem is developed, the innermost layer of this fluid acquires consistence, is organised, becomes hardened, and changes into liber, which at the end of the first year, is found to be converted into a soft and half-formed woody substance. Autumn arrives, and vegetation is arrested in this state. The outer layer of the cambium, which has not yet entirely changed its nature, remains stationary, and as it were torpid. But, at the return of spring, when the gentle heat of the sun awakens vegetables from their winter's sleep, the cambium resumes its vegetative power. It developes the buds and the new roots, and, when it has produced all the parts that are to serve for supporting the life of the vegetable, it gradually hardens, becomes compact, and undergoes the same changes as that which preceded it. But, in proportion as these changes are effected, as the liber hardens and changes its nature, as the layer which it has replaced acquires greater solidity, a new liber is developed. From all parts of the outer surface of that which is ready to be converted into wood, there exudes a viscid humor, under the form of small drops, which spread and unite. This is a new cambium, a new liber, which is about to be organized, and to pass through the different stages of growth that have been gone through by those which have preceded it, and from which it has derived its origin.

Such are the means which nature employs for renewing each year successively the vegetating part of the stem. It is here that the greatest difference between woody stems and herbaceous stems presents itself. In woody stems, it is to the successive development of a new layer of liber that the tree owes its duration and the continuance of its vegetation. In herbaceous stems, on the contrary, all the cambium is consumed in producing the different organs of the plant, and at the end of the year it is found to be entirely converted into a kind of ligniform, dry, and arid substance. There does not, therefore, remain, as in the woody stem, a certain quantity of gelatinous matter, to which is confided the charge of preserving, from year to year, the germs of a new vegetation, and the plant necessarily dies, for want of a substance qualified to renew its development.

Having thus explained the theory of the formation of woody layers by means of the annual transformation of the liber into alburnum, we shall next make known the theory which has been proposed by Du Petit-Thouars, and which, to many physiologists, has formed a subject of so much dispute.

The successive formation of the woody layers, in other words, the growth in diameter, is produced by the development of the buds.

In Du Hamel's theory, the liber performs the principal part in the phenomena of the growth in diameter; but here the buds are the most important instruments in that operation. Du Petit-Thouars having remarked that the buds are seated upon the external parenchyma, and that their fibres communicate with those of the scions or young branches which support them, has drawn from these circumstances the following conclusions, which form the basis of his theory of vegetable organization.

1st, Buds are the first perceptible phenomena of vegetation. All the parts which in vegetables are to be developed at the exterior, are at first contained in buds. There is one in the axilla of every leaf; but this bud is apparent in dicotyledonous plants only, and, among the monocotyledones, in the single family of the grasses. In the other monocotyledones, the bud is latent, and consists merely of a vital point, which, in certain circumstances, is susceptible of being developed in the manner of the buds of dicotyledonous plants.

2dly, By their development, buds give rise to scions or young branches, which are furnished with leaves, and most commonly with flowers. Each bud has an existence in some measure independent of that of the other buds. Du Petit-Thouars considers them as analogous in their structure and development to the embryos contained in the interior of seeds, which, through the act of germination, develope a young stem, that may be compared to the scion produced by the evolution of a bud. Accordingly, he has given the name of *fixed* or adherent embryos to the latter, in opposition to that of *free* embryos, which he applies to those contained in the interior of the seed.

3dly, If we examine the interior of these buds on a scion or young branch of the year, we shall find that they communicate directly with the internal parenchyma or pith. Now, this pith, as before mentioned, is at first green, and its cellules are filled with an abundance of aqueous fluids. It is from these fluids that the buds derive the first materials for their development. They are thus nourished at the expense of the internal parenchyma, and, by absorbing the fluids which it contains, dry it up, and convert it into pith, properly so called, which is more or less opaque or transparent.

4thly, As soon as these buds make their appearance, they obey two general motions, the one ascending or aërial, the other descending or terrestrial. It is here that M. Du Petit-Thouars finds a similarity in the structure and uses of buds to those of the seed-embryos. He considers buds in some measure as germinating embryos. The layer of cambium situated between the bark and the wood is, with respect to the bud, analogous to the soil in which the seed begins to

germinate. Its aërial evolution gives rise to a scion, or young branch; while from its base, that is, from the point by which it adheres to the parent plant, proceed fibres, which the author compares to the radicle of the embryo, and which, gliding along in the moist layer of cambium, between the liber and alburnum, descend to the lower part of the vegetable. Now, in their course downwards, these fibres meet those which descend from other buds, unite with them, and thus form a layer more or less thick, which acquires consistence and solidity, and forms each succeeding year a new woody layer. The liber, when once formed, does not change its nature, or undergo any transformation.

This theory is extremely ingenious, and the author adduces several facts in proof of its accuracy. Thus, he says, when a strong circular ligature is applied to the trunk of a dicotyledonous tree, a swelling or rim is formed above the obstacle, and no growth in diameter takes place below the ligature. This swelling is formed by the woody fibres which descend from the base of the buds, running in the cambium situated between the liber and alburnum. These woody fibres meet an obstacle which they are unable to surmount, are stopped, and accumulate there. Henceforth no new woody layers can be formed beneath the ligature, as the fibres of which they are formed cease to arrive there. Such is the explanation given by M. Du Petit-Thouars of the phenomena presented after the application of a ligature, which most authors account for in quite a different manner.

He farther adduces, in support of his theory, the phenomena exhibited in consequence of the act of grafting. In grafting by *inoculation*, it is usual to take a bud which is yet stationary, and apply its base to the layer of cambium which has been laid bare. After this the radicles or fibres which proceed from the base of the bud, glide between the bark and alburnum, and the new stock is thus identified with that on which it has been grafted.

As a confirmation of this fact, this botanist has had in his possession a branch of *Robinia pseudacacia*, on which has been grafted a young scion of *Robinia hispida*. The stock died, but the graft having continued to vegetate, there is seen proceeding from its base a mass formed of very distinct fibres, which embrace the extremity of the branch to a considerable extent, and form a kind of sheath for it. In this example, it is perfectly clear that the fibres descend from the base of the graft to spread over the stock.

Notwithstanding all the arguments brought forward by the author in defence of his theory, it has not as yet been entirely adopted by any physiologist. On the contrary, almost all authors who treat of vegetable physics have in some degree opposed it. The principal arguments that have been brought against it are the following: 1*st*, It has been said that there is no incontrovertible proof that the fibres which establish a communication between the buds and the stems which support them, descend in the manner alleged from these buds to the roots. To this, however, our theorist replies, that the buds are indeed the source, the first origin, of the woody fibres, but that they do not furnish all the materials of the elongation of these fibres; for when the latter have once emerged from the base of the buds, they are found to be immersed in the cambium, where they absorb all that is necessary for their growth. 2*dly*, It has been objected that the phenomena of the circular swelling which forms after a ligature has been applied to the trunk, may be accounted for by the interception and stagnation of the descending sap. But, says Du Petit-Thouars, the experiment of Hales, which was confirmed by Du Hamel, affords a refutation of this objection: Two cylinders of bark having been completely insulated by the removal of three rings, one of the cylinders being furnished with a bud, while the other had none, the result was that a circular swelling formed on the first cylinder only, thus affording an evident proof that the buds give rise to the woody fibres. 3*dly*, It is impossible to conceive how fibres so slender as those which unite the buds to the stems could, in a space of time so short as that during which the stem grows in diameter, descend, by their proper weight, from the summit of a tree sixty or eighty feet high to its base. As the opinion of the learned academician is not that the fibres issue and descend ready formed from the base of the buds, but, on the contrary, that they form as they pass through the layers of cambium, this objection requires no refutation. 4*thly*, That, since the woody layers are formed of the fibres which descend from the base of the buds, if, in grafting by inoculation, a bud taken from a tree having coloured wood, is grafted upon an individual having white wood, the fibres which proceed from this bud ought to retain their colour, and the new woody layers which they form ought to be similarly coloured; but this is not the case. This objection, which has been considered as one of the strongest that have been adduced, our author finds little difficulty in refuting, it having originated in a misconception of the author's opinion. In fact, as Du Petit-Thouars has constantly stated, the fibres coming from the base of the bud are nourished by the cambium of the branch at whose surface they are formed. Now, in the case of grafting with two trees, the wood of which is differently coloured, so long as the new fibres are immersed in the cambium of the piece that has coloured wood, they retain their natural tint; but, when they are formed at the expense of the cambium of

the piece that has white wood, they assume the same colour. *5thly*, If it be the development of the buds that gives rise to the formation of the wood, how can the first woody layer itself form on a young shoot of the first year, when as yet none of the buds which it supports have been developed? According to the celebrated academician whose theory we are here explaining, at the moment when a bud is developed to form a scion, the leaves which compose it separate from each other, leaving spaces between them. If at this period we examine the internal structure of the young shoot, we see that from the base of each leaf there proceeds a bundle of fibres, which, by joining those from the other leaves, forms the medullary tube; but as these leaves become developed, there appears in the axilla of each of them a bud, which subsequently tends to establish its radical communication, by shooting forth woody fibres, which gradually cover the medullary tube, and form a continuous layer around it.

The two theories which we have just stated cannot then be adopted in all their parts, as affording a satisfactory explanation of all the phenomena of the growth of vegetables in diameter. That of Du Hamel is essentially founded upon the annual transformation of the liber into alburnum, and its reproduction by means of the layer of cambium. The experiment by which that celebrated naturalist having passed a silver wire into the liber, found it the following year in the alburnum, is altogether incorrect: none of those who have repeated the experiment after Du Hamel have obtained the same result; and when the silver wire had actually been passed through the liber, it was always found again in that organ, and not in the alburnum. This theory must therefore of necessity fall, if we sap the foundation on which its author raised it. The following is the explanation which appears to agree best with facts.

The annual formation of woody layers is owing to the cambium, which every successive year forms at once a new layer of alburnum and a new layer of liber.

This is the opinion which Mirbel has latterly professed, and which appears to have the greatest number of probabilities in its favour.

The liber, hitherto considered as the most essential organ of vegetation, and that which contributes each year to the increase in diameter of the trunk of dicotyledonous trees, being, on the contrary, neutral and passive in this operation, another explanation of the phenomena of growth in diameter must be sought for. The following, then, is that which seems the most probable, and the most conformable to the strict observation of facts. If we examine a young branch at the period of vegetation, that is, when the sap circulates abundantly in all parts of the vegetable, we find the following appearances:— Between the liber and alburnum is seen a layer of a fluid, which, at first colourless and limpid, gradually thickens, and acquires consistence. This fluid, the *cambium*, is formed by the descending sap, mixed with part of the proper juices of the vegetable. As the cambium thickens, filaments are seen to form in its interior, and it is presently organized, and assumes the appearance of a vegetable tissue. This transformation is gradual, and continues during the whole period of the development of the buds, so that the formation of the annual layer takes place in a slow and progressive manner. It is for this reason that the new layers of alburnum very frequently present several concentric zones, which show that their whole thickness has not been formed at once.

The alburnum is not therefore formed by the liber, which thickens and acquires more consistence, but by the cambium, which is organized, and thus becomes the agent of growth in diameter, giving rise each successive year to the formation of a layer of alburnum and a layer of liber, both distinct from each other, although deriving their origin from the same organ. When Du Hamel found in the alburnum the silver wire which he thought he had inserted in the liber, it was because he had passed the wire through the organic layer of the cambium.

It also follows from this, that the liber increases every year in thickness, by its inner surface; for the layer of cambium, which bathes its inner surface, becomes organized, and is added to the liber, so that the latter gradually becomes thicker. It is on this account that the liber is found to be formed of several laminæ or leaves, which are connected with each other by an excessively thin layer of cellular tissue.

In this manner, then, a new woody layer is formed each year in the trunk of dicotyledonous trees. This new layer is produced by a part of the cambium, which is organized and becomes solid. The alburnum formed the preceding year acquires more density, and changes into wood. But the liber undergoes no transformation; it is merely renewed and increased at its inner surface by means of a part of the cambium, which successively forms new laminæ. It is by this mechanism that the growth in thickness of the stems of dicotyledonous trees seems to be effected. We shall now explain their development in height.

Growth in height. At the period of germination, the radicle sinks into the ground, while the ascending gemmule shoots upwards. The first layer of cambium becomes organized, and obeys this impulse. Towards autumn, when it is organized into alburnum and liber, its growth stops. When, at the return of spring, vegetation recommences, the vegetable tissue is gorged

with nutritious fluids, that vivify the buds. From the upper part of the stem proceeds a new centre of vegetation, from which rises a new shoot, which in its development exhibits the same phenomena as the first. To this second shoot succeeds a third, which the following year is surmounted by a fourth, and so on.

The trunk is therefore found to be formed by a series of very elongated cones, placed upon each other, and having their apex directed upwards. But the apex of the innermost cone stops at the base of the second shoot, that of the next cone at the base of the third shoot, and so on successively, it being only at the base of the trunk that the number of woody layers corresponds to the number of years of the plant. Thus, for example, a stem of ten years has ten woody layers at its base, but presents only nine at the height of the second shoot, eight at the third, and finally only one at the top. It is for this reason that the trunk of dicotyledonous trees is more or less conical, the number of its woody layers becoming gradually less, as they ascend from the base to the summit.

There are trees in which this growth in height is very manifest; as in pines and firs. At the end of the first year, there is seen at the top of the stem a conical bud, from which proceeds a whorl of young branches, at the centre of which is one that rises vertically. It is this branch which is destined to continue the stem. At the end of the second year, there proceeds from its summit a similar bud, which, in its development, presents the same phenomena. Thus the age of these trees may be known by the number of whorls of branches which they have on their stem.

Growth of the stem of monocotyledonous trees. If we examine the growth of the stipe of a palm, we find that it takes place in the following manner:—After germination, the leaves, which are generally folded upon themselves, become expanded, and form a circular bundle, arising from the neck of the root. From the centre of this bundle there issues, the second year, another tuft of leaves, which push outwards those previously existing. Then the oldest fade, dry, and fall off; but their bases, being firmly fixed to the summit of the root, remain without withering; and, by uniting, form a solid ring which becomes the base of the stipe. A new central bud being developed every year, the outermost leaves of that which precedes it, fall off, and their base forms a new ring, which is added above those that already existed.

Such is the development of the stem of monocotyledonous plants. Their stipe, in place of being formed of concentric layers, like the trunk, of the dicotyledones, is composed of rings placed one above another. From this it will be seen, that the trunk of the monocotyledones can grow but very little in thickness. In fact, its lateral growth can take place only inasmuch as the persistent base of the leaves is not yet sufficiently solidified and hardened to resist the outwards pressure which the bud tends to exercise upon it. Accordingly, we see that the palms, which sometimes shoot up to a height of 120 or 140 feet, have a stem which is often scarcely a foot in diameter.

In dicotyledonous trees, the cambium is the essential agent by which the enlargement of the stem is effected, as it every year becomes organized, and forms a new woody layer. Here, on the contrary, it is the terminal bud which crowns the stipe that performs this office; and, were this centre of vegetation removed, the tree would inevitably perish.

If we compare, in a general way, the growth in diameter of the stem of dicotyledonous trees and that of the monocotyledones, we shall find that it differs not less than their anatomical structure. In the dicotyledones there are two distinct systems; the *central system*, formed of the medullary tube and the woody layers, and the *cortical system*, which is composed of the bark. These two systems enlarge separately, so that there are two surfaces of growth in this class of vegetables. The central system increases by the new layers which are added to its outer surface, and the cortical system increases by its inner surface.

In monocotyledonous vegetables, on the contrary, there is but a single surface of growth, and consequently but a single system; hence, it may be inferred that the system which exists in these plants, is the cortical, and that the central system is wanting. It follows that the stipe of the palms is organized like the bark of the dicotyledones.

From these different considerations, it is obvious that the stipe of palms, and other woody monocotyledonous vegetables, differs essentially, both in its organization and in its mode of development, from the trunk of dicotyledonous vegetables. If we extend this observation farther, it will be seen that as the stipe differs so much from the trunk, in its origin and mode of growth, it is not surprising that its internal organization, which is merely the result of this mode of development, should equally differ from that of the woody stem of dicotyledonous plants. For, let it be recollected, how the stem of an oak, or any other dicotyledonous vegetable, is formed and grows:—the seed germinates; the radicle descends into the ground; the little stem, or its representative organ, which serves as a support to the gemmule, and raises it above the base of the radicle, ascends. At this early period in the life of the plant, the organ which is to constitute the stem already exists under the form of a more or less elongated cylinder, composed

internally of a cellular tissue, representing the medulla, and externally of tubes or fibres, constituting the first rudiments of the wood, the bark, and in general all the filamentous parts of the stem. We proceed to examine a palm-seed at the period of germination. Its radicular extremity elongates more or less, bursts at its summit, to permit the escape of the radicle, which was previously imprisoned in a kind of closed bag, named the *coleorhiza*, which it tears in order to penetrate into the ground, and become the root. The opposite extremity to the radicle, the cotyledon, assumes a slight development, but is presently seen to split on one of its sides, beneath its summit; and through this slit or rupture, issues a variable number of leaves, at first, embracing each other. But in this embryo of the palm, we see no rudiment of the stem, as in the embryo of the oak, lime, pine, and other dicotyledones. The organ to which that name is ultimately given, has to be gradually formed at the expense of another organ. As we have already explained, the bases of the leaves which are successively developed, approaching closer to each other, in consequence of the pressure exerted upon the outermost, in proportion as new ones are developed within, adhere together, and ultimately form a kind of fleshy platform, composed of cellular tissue, and traversed by scattered fibres. What is called the stipe or trunk in the palm, is therefore an organ composed of a great number of scales, which are only the bases of leaves more or less united together, and presenting at their interior a central and terminal bud, which is its essentially vegetating organ. Thus, then, the stipe of a palm is not really a stem, whether we consider it as to its origin and development, or its organization. Something of this same nature occurs in other plants, especially in the subterranean stem, or what is commonly called the root, of the genus iris. It is a fleshy body, having some longitudinal fibres in its interior, and presenting, at its outer surface, the cicatrices of the scales which compose it. If we follow its development, we find that it owes its formation to the bases of the leaves, which having remained unwithered, while their upper part has been destroyed, have united together and formed the fleshy body, which, in the genus iris, is commonly designated by the names of root, rhizoma, stock-root, or subterranean stem. Consequently, this organ, like the stipe of the palms, is in reality neither a root nor a stem, but a collection of bases of leaves all united into a single mass. A species of garlic, *allium senescens*, presents an organ precisely similar, being a more or less fleshy and branched stock. From this stock of *allium senescens* and the genus *iris*, does there not appear to be a gradual transition to the solid or scaly bulbs of the lilies? A bulb is merely an organ composed of scales, varying in their form and disposition, but always seated on a fleshy platform, and covering a central and terminal bud; while the scales themselves are nothing but leaves, whose base alone is developed, or whose base alone has remained unwithered, while the upper part has been destroyed. If, as has been presumed, the subterranean stock of the iris has the same origin, the same mode of development, and the same organization as the stipe of the palms; and if, on the other hand, there is no perceptible difference between the alleged stock of the iris and the bulb of most of the lilies, it appears impossible not to draw the conclusion, that the stipe of the palms, in place of being a stem, is in fact merely a bulb. This opinion might seem paradoxical to a person who should not overlook the general form, the size and duration of the stipe of the palms, compared with the bulb of other monocotyledonous plants. But if we reflect attentively that these different properties are not essential to the nature of that organ; that they are often wanting in a great number of species; that in some the stipe, in place of being long and cylindrical, is short, scarcely perceptible, and sometimes consists merely of a kind of bulbiform enlargement; that, in other species, this stipe, so far from being hard and woody, is soft and fleshy, and is easily penetrated by cutting instruments, these differences, which at first seem so striking, instantly disappear. If, on the other hand, we examine the origin, the mode of formation, and the manner of growth of the stipe compared with those of the bulb, we must conclude that the two organs are essentially the same.

In this manner of viewing the stipe, we can easily account for the circumstance of its being so rarely branched. It is well known that a branch is never any thing else than the result of the elongation of a bud, generally placed in the axilla of a leaf. Now, in the monocotyledones, these axillar buds are almost always abortive, or remain in the rudimentary state, as in most of the grasses. This is also the case in the palms: their axillar buds generally remain in the rudimentary state, and then the stipe is perfectly simple; but, in certain circumstances, some of these buds receiving more nourishment than the rest, are developed, or in other words, the leaves composing them, which unite together at their base, ultimately form a new stipe proceeding from the first. This is what takes place in certain species of *yucca*, in the Doom Palm of Upper Egypt, &c.

Hitherto the growth in diameter was generally admitted as the exclusive result of the new layers which are added every year between the alburnum and bark. Dutrochet has proved that vegetables increase in diameter in two direc-

tions; 1st, In *thickness*, by the formation of new layers between the bark and alburnum; and 2dly, In *breadth*, by the lateral development of the new layer and the formation of new bundles of fibres. This growth, in the direction of the thickness and breadth, takes place equally in the roots and stems.

It was on the stem of *Clematis Vitalba* that Dutrochet made his first observations. When the extremity of a young branch of that plant is cut across, it is found to be composed of six bundles of longitudinal fibres, separated from each other by medullary rays or spaces of considerable breadth. By degrees, and in the progress of vegetation, there forms at the centre of each medullary space a new bundle of longitudinal fibres, which presently acquires the same size as the six original bundles, so that, by the end of the first year, the stem is found to be composed of twelve bundles of fibres, separated by an equal number of medullary rays.

In the course of the second year, each of the six original bundles is divided into three by the median production of a new bundle of longitudinal fibres, separated from the other two, between which it has been developed, by two imperfect medullary rays, which do not reach the central medulla. On the other hand, the six other secondary bundles of the first year divide each into two, by the formation in their middle of a new imperfect medullary ray. From this there results, that, at the end of the second year, there are thirty bundles of fibres, separated from each other by an equal number of medullary rays or spaces, of which twelve only, viz., those which existed at the end of the first year, are complete, and establish a direct communication between the external and the internal medulla.

If we attend to the manner in which the bundles of longitudinal fibres have been multiplied, we shall see that the growth has taken place in a lateral direction; for the median production of new bundles of fibres at the centre of the medullary rays, or that of new medullary rays at the centre of the bundles of fibres, would necessarily produce a lateral dilatation, and consequently increase the width of the circular layer in which this development had been effected. This lateral dilatation was first perceived by the able experimenter, whose observations we here relate.

The growth in breadth stops in the parts the moment they become solid. Thus it no longer takes place in the woody layers; but it continues in the bark, and it is thus that it allows the woody layers to increase in thickness.

The growth *in breadth* takes place in the roots also, as we have already said; but, in that organ, it always commences by the median production of new medullary rays at the centre of the bundles of fibres. Subsequently, these new medullary spaces themselves give rise to other collections of fibres.

From what has been said above, it will be seen that the organic elements of vegetables have a natural tendency to the *median production*. Thus the bundles of fibres tend to produce new medullary rays in their middle part, and, on the other hand, the medullary rays tend to produce new bundles of longitudinal fibres.

Having stated Dutrochet's opinion respecting the growth in breadth, we now proceed to give an account of his ideas on the development *in thickness*. The woody layers of new formation which are developed each year, are separated from the old ones by a thin layer of central medulla. These layers of medulla, which separate the woody layers from each other, are not always easily perceived; but they are very distinct in some trees, for example, in *Rhus typhina*, where their darker colour distinguishes them at first sight from the layers of wood, which are lighter. In spring, the growth in thickness always commences by the formation of this thin layer of cellular or medullary tissue. Soon after, in consequence of the faculty which it possesses of giving rise to longitudinal fibres, this layer of pith produces vessels which surround it, and thus forms a kind of medullary canal, which is destined at a later period to become the new woody layer.

In this theory we see the important function which the author attributes to the pith. It becomes the essential agent of the growth in diameter, as it gives rise to the vessels which are subsequently to form the new layer of wood.

The same phenomena take place in the liber. Each of its folds is separated by a thin layer of cellular tissue, which belongs to the cortical medulla, and by means of which the annual growth is effected.

Theory of engrafting. The most natural and most easy means of multiplication in vegetables is undoubtedly by seeds, and it is that by which the vegetables dispersed over the surface of the globe are naturally renewed; but there are others which art frequently employs to perpetuate and multiply certain races or varieties of trees which cannot be propagated by seed. The processes here alluded to, are the propagation by layers, by slips, and by grafts. We shall state the theory of these three operations in a general manner, and with reference to vegetable physiology. An account of the practical art of engrafting will be given afterwards.

1*st*, Propagating by *layers* is an operation by which the base of a young branch is surrounded with earth, and made to shoot forth roots, before it is separated from the parent stock. Sometimes this operation is performed upon the lower branches of a young shrub which are bent

downwards and covered with earth; and sometimes it is made upon the upper branches, which are made to pass through a vessel filled with peat-earth. To facilitate this process, an incision is generally made at the base of the young branch, or a tight ligature is applied to it, in order to favour the formation of roots. These roots are buds which, on being immersed in earth, become elongated into slender radicular fibres; whereas, if left in the air, they would be developed into young scions. This mode of propagation is employed for many plants, such as Pinks, Hortensiæ, Heaths, Gooseberries, &c.

2dly, Propagating by *slips* differs from the preceding method in this respect, that the young branch is separated from the stock previously to its being fixed in the ground. There are trees of which slips take root very readily. In general, those of which the wood is white and light succeed best. Thus a slip of willow, poplar, or lime, on being stuck in the ground, takes root there in a short time, and soon shoots up vigorously. A slip succeeds with more certainty when two or three young buds are left under ground; that is, upon the lower part of it. These buds become elongated into roots, which singularly aid the suction by which the development of the young scions is to be effected. Not unfrequently incisions are made at the base of the slips, or ligatures applied, to facilitate the growth of the roots. Sometimes they are even split longitudinally at their base, and a piece of sponge, soaked in water, is inserted. Some woody species are very difficult to be propagated by slips, such as the pines, oaks, heaths, and in general trees with very dense or resinous wood.

3dly, *Grafting* is an operation by which a bud or young scion is inserted upon an individual, and is there developed so as to become identified with the stock on which it has been placed. Grafting can only succeed when it is performed between vegetating parts. Thus, wood cannot be grafted, nor even alburnum. In the operation and phenomena of grafting, the great similarity which exists between buds and seeds, especially with respect to their development, may be remarked. These two organs are destined to give rise to new individuals, some of which live at the expense of the stock on which they are developed; while the rest subsist by themselves, and without requiring foreign assistance.

It is to be remarked, that grafting, or union of parts, can take place only between vegetables of the same species, species of the same genera, or, lastly, genera of the same family; but never between individuals belonging to different natural orders. For example, the peach may be grafted upon the almond, the apricot on the plum, the pavia on the horse-chestnut; but the operation would not succeed between the latter tree and the almond, it being necessary that there should be a kind of agreement or similarity between the sap of the two individuals before the union of a graft can be effected.

It is the cambium or proper juice of vegetables that serves as a means of union between the individual and the graft, in the same manner that in animals coagulable lymph is interposed between the two lips of a recent wound, which it brings together and unites. When the wound of a graft is examined about a fortnight after the operation, a thin layer of small greenish granulations, dispersed in a viscid fluid, is seen between the two parts that have been brought together. These granulations, the rudiments of vegetable organization, are produced by the cambium, which becomes solidified and organized; and this phenomenon takes place whenever a superficial wound is made upon a tree, provided the contact of air be prevented.

Several advantages are derived from this method of multiplying vegetables. Thus, it is used for perpetuating remarkable varieties or monstrosities, which could not be reproduced by means of seed; for procuring quickly many interesting trees, which are with difficulty multiplied by any other means; for hastening the fructification of certain vegetables by several years; for improving and propagating the varieties of fruit-trees, &c. There are four different methods of engrafting.

1. *Grafting by approach.* This process is performed between two plants growing by the roots, and which it is intended to unite by one or more points. For this purpose, wounds exactly corresponding to each other are made upon the parts which are to be grafted. Plates of bark of equal size are removed, and the wounds thus produced are kept together, and protected from the contact of air, when union takes place between them. By this method, stem, branches, and roots may be united, and fruits, or even flowers, may be grafted upon leaves.

2. *Grafting by scions.* Grafting by scions is performed with young twigs, or even with roots, which are separated from the parent plant to be placed upon another, in order to live upon it and be developed at its expense. The twigs which are to be grafted are generally separated some days, and in some cases even several months, before the operation is performed, that they may have less sap than the stocks on which they are to be placed. In this case, they are kept alive by immersing their lower extremity in water or in earth.

Before this kind of grafting is performed, the head of the stock on which it is to be practised is commonly cut off. Sometimes the stock is cut close to the ground, especially in trees in which the graft requires to be placed in the earth, as in the vine, &c. Before this species of grafting can succeed, it is necessary that the

liber of the graft should correspond in the greater part of its extent with that of the stock on which it is inserted.

Grafting by scions is managed in several ways. Sometimes the head of the stock is split into two, and the twig to be grafted is inserted in the slit. This operation is known by the name of *cleft-grafting*. Sometimes the bark is separated from the subjacent woody layers, and several small twigs disposed in a circular manner between them. This method is named *crown-grafting*. At other times the trunk of the tree is perforated, and a young branch fitted and permanently fixed to it. This method, which is now little employed, bears the name of *wimble-grafting* or *peg-grafting*. Occasionally grafting by scions is practised upon young twigs covered with leaves, flowers, and even young fruits. In this case, it is effected during the full flow of the first sap. By this process, it is not uncommon to obtain fruit from a tree fifteen or twenty years sooner than it would otherwise have produced it. It has even happened, that, in sowing a seed at a particular period, ripe fruit has been obtained from it before the end of the year.

Grafting by scions is also practised without cutting off the head of the stock, a notch being made on one of its sides, to which the graft is applied. This is named *side-grafting*, and is principally used for the purpose of repairing the head of a tree which has lost some of its branches.

Lastly, to this section may be referred the grafting which is performed with a scion upon a root left in its place, or with a root upon the root of another stock.

3. *Grafting by buds*. This consists in transferring to another individual a plate of bark to which one or more buds adhere. Of this kind also is scutcheon-grafting, flute-grafting, and other varieties. Bud-grafting is the most generally practised, especially for multiplying fruit-trees, it being more easily and expeditiously performed than any other operation of this nature. It is performed in spring, at the time when the sap ascends, or in August. The form to be given to the graft, and that of the incision, vary greatly according to the peculiar mode employed.

4. *Grafting of herbaceous parts of vegetables*. The discovery of this kind of grafting dates from a recent period, a few years only having elapsed since it was for the first time practised. It may be performed with the young herbaceous shoots of trees, during the full flow of the sap, or with annual plants. In order that this graft may succeed, it must be inserted into the axilla, or into the vicinity of a living leaf of the stock. This leaf serves to draw the sap into the graft, and to facilitate its union and development. The methods employed are much the same as for the other kinds of grafting.

Size of trees. Trees are, in general, larger and taller, in proportion as the climate and the situation in which they grow are adapted to their nature, and prove favourable to their development. A certain degree of humidity, joined to a pretty high temperature, appears to be the circumstance most favourable to the growth of trees; and in regions possessing these conditions of the atmosphere, they attain the greatest height. The forests of South America are, in general, composed of trees greatly exceeding ours in their breadth and height, and the beauty of their foliage and flowers.

Certain trees take a long series of years in acquiring any considerable height or diameter; as the oak, the elm, and the cedar. Others, on the contrary, grow much more rapidly. They are chiefly trees which have light and soft wood, as poplars, pines, Acacias, &c. Lastly, there are plants which grow with such rapidity, that the eye can, in a manner, follow the progress of their development. Of this kind is the *agave Americana*, or American aloe. This plant, which covers the rocks along the shores of the Mediterranean, in the gulf of Genoa, when it flowers, shoots out a stalk which sometimes acquires a height of thirty feet, in the space of thirty or forty days, or even less. As it grows about a foot in a day, its successive development should be perceptible to the observer.

In general, the greatest height which the trees of our forests attain is from 120 to 130 feet. In America, palms and many other trees often exceed 150 feet. Trees vary as to their diameter, not less than in height. Some of them occasionally acquire monstrous dimensions.

In Britain, oaks of a great age have been known to measure upwards of forty feet in circumference at the base of the trunk, with an elevation of ten or twelve feet without any division. At Colthorpe, near Wetherby in Yorkshire, there is now growing an oak that measures seventy-eight feet in circumference close to the ground, and forty-eight feet at the height of a yard. It is said to have begun to decline in the reign of Queen Elizabeth, and though now much in decay, is still likely to stand for many years.

The *araucaria*, a pine of Norfolk Island, is found of the extraordinary height of 267 feet, the width at the base being twelve feet, while at the height of eighty feet it continues of the same diameter. Breton * describes another tree in New South Wales, having a triangular trunk, one side of which was eighteen feet in width; another nineteen feet, the third twenty-two feet; making a total width of fifty-nine feet.

"I measured," says Mr Darwin, "one of those noble trees called the Kauri Pines, in a part which was not enlarged near the roots, and found

* Sketches of New South Wales.

it to be thirty-one feet in circumference. There was another close by which I did not see, thirty-three feet, and I heard of one not less than forty feet. The trunks are also very remarkable for their smoothness, cylindrical figure, absence of branches, and having very nearly the same girth, with a length from sixty to ninety feet. The crown of this tree, where it is irregularly branched, is small, and out of proportion to the trunk, and the foliage is likewise diminutive, as compared with the branches. The forest was almost composed of the kauri, and the largest, from the parallelism of their sides, stood up like gigantic columns of wood. The timber of these trees is the most valuable product of the island; moreover, a quantity of resin oozes from the bark, which is collected, and sold at a penny a pound to the Americans, but its use is kept secret."

Trees, when placed in suitable soil, and in a situation adapted to their nature, are capable of living for centuries. Thus the olive-tree may continue for 300 years, and the oak about 600. The cedars of Lebanon seem in a manner incapable of decay. According to very ingenious calculations, Adanson supposed that the baobab might be many thousand years old.

In dicotyledonous trees, the age may be known by the number of woody layers which a transverse section of the trunk presents. As a new layer of wood is formed every year, it will easily be seen that a tree twenty years old, must present at its base twenty concentric rings of wood, and so on successively. In the trees of tropical climates, however, this annular indication is less to be depended upon, and may, as in the case of the baobab, lead to erroneous conclusions.

Uses of stems. Wood is applied to so many uses in domestic economy and the arts, and is so indispensable in the construction of ships and buildings of all kinds, as well as of machines and instruments, that no part of vegetables can dispute the superiority with it in this respect.

Many herbaceous stems are employed as food for man and animals. The stem of the sugar-cane supplies most of the sugar of commerce. Many woods are used for dyeing: for example, sandal-wood, logwood, brazil-wood, &c. Leather is tanned with oak-bark, and, in general, with those kinds of bark which contain a great quantity of tannin.

With respect to medical properties, the stems, the wood, and the bark, are of essential importance. To these belong the cinchonas, cinnamon, winter's-bark, sassafras, guyacum, and many other medicines which possess so well-merited a reputation.

Various operations are often practised on the trunks of trees. *Incision* is sometimes necessary to the health of the tree, in something of the same way as bleeding is to the health of an over full animal. The trunk of the plum and cherry tree seldom expand freely till an incision is made lengthwise along the trunk, and hence this operation is often practised by gardeners. If the incision only extends through the epidermis, it heals up without leaving any scar; if it penetrates into the interior of the bark, it heals up only by means of leaving a scar; but if it penetrates into the wood, the wood itself never heals up completely, but new wood and bark are formed above it. *Boring* is an operation to which the trunks of trees are often submitted, for the purpose of making them part with their sap in the season of their bleeding, particularly the birch and the American maple. A horizontal, or rather slanting hole, is bored in them with a wimble, so as to penetrate an inch or two into the wood; from this the sap flows copiously, and though a number of holes is often bored in the same trunk, the health of the tree is not materially, if at all affected; for trees will continue to thrive though subjected to this operation for many successive years, and the hole, if not very large, will close up again like the deep incision, not by the union of the broken fibres of the wood, but by the formation of new bark and wood projecting beyond the edge of the orifice, and finally shutting it up altogether. *Girdling* is an operation to which trees in North America are often subjected, when the farmer wishes to clear his land of timber. It consists in making parallel and horizontal incisions with an axe into the trunk of the tree, and carrying them quite round the stem, so as to penetrate through the alburnum, and then to scoop out the intervening portion. If this operation is performed early in the spring, and before the commencement of the bleeding season, the tree rarely survives it; though some trees that are peculiarly tenaceous of life, have been known to survive it for a considerable length of time. If a tree is bent so as to break part only of the cortical and woody fibres, and the stem or branch is but small, the parts will again unite by being put back into their natural position and well propped up, especially if the fracture occurs in spring, when the juices are in abundance; but it will not succeed if a contusion has crushed and destroyed the vessels; or if the stem is very large, even where it succeeds, the woody fibres do not contribute to the union, but the herbaceous substance only, which exudes from under the liber, and which insinuates itself through all the interstices. In pruning for repressing the excessive growth of branches, a slanting division of the branch is made close to the trunk; in this case the wound soon closes up by the meeting of the opposite sides of the cut bark.

CHAP. VIII.

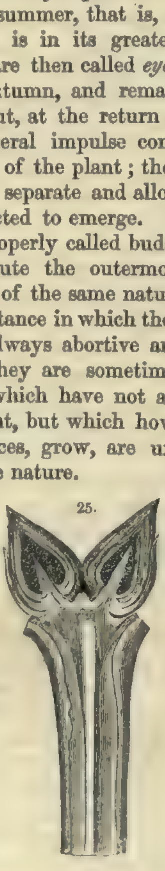
OF BUDS.

Buds (*gemmæ*) are bodies of varied form, nature, and aspect, generally formed of scales closely imbricated upon each other, and containing in their interior the rudiments of stems, branches, leaves, and organs of fructification. They are always developed upon the branches, in the axilla of the leaves, or at the extremity of the twigs. They are oval, conical, or rounded, composed of scales which are superimposed upon each other, covered externally, in the trees of our climates, with a viscous and resinous coating, and furnished internally with a downy tissue, destined to defend the organs which they enclose from the rigours of winter. Accordingly, no envelopes of this kind are observed on the trees of the torrid zone, nor upon those which are reared in the shelter of our hot-houses; but those vegetables which are destitute of them are unable to resist the cold of our winters, and would unavoidably perish were they exposed to it.

Buds begin to appear in summer, that is, at the period when vegetation is in its greatest vigour and activity. They are then called *eyes.* They enlarge a little in autumn, and remain stationary during winter: but, at the return of spring, they follow the general impulse communicated to the other parts of the plant; they dilate and swell, their scales separate and allow the organs which they protected to emerge. It is then only that they are properly called buds.

The scales which constitute the outermost part of the buds, are not all of the same nature or origin. The only circumstance in which they all agree, is, that they are always abortive and imperfect organs. Thus, they are sometimes leaves, petioles, or stipules, which have not acquired their full development, but which however, in certain circumstances, grow, are unfolded, and disclose their true nature.

25.



a

The annexed figure, which is a section of a branch of the ash, exhibits the manner in which buds originate from the parent stem; *a* is the medullary canal containing the pith. The pith is also visible in the centre of each of the buds; but the pith of the bud, or branch, and that of the stem, do not at first communicate, nor do they join till the second year.

Buds are divided into *naked* and *scaly.* The first are those which have no scales at their exterior, and of which all the parts shoot out and become developed. Of this kind are the buds of most herbaceous plants. Scaly buds, on the other hand, are those whose outer part is formed of more or less numerous scales, as may be observed in the trees of our climates.

Buds are, in general, visible externally long before they expand. There are trees, on the contrary, in which they are, as it were, immersed in the very substance of the wood, and only make their appearance just when they are about to be developed; as in the acacias, and many other legumines.

Buds may be *simple,* that is, may give rise to a single shoot only; as in the lilac and oak: or *compound,* containing several stems or twigs; as in the firs. According to the parts which they contain, they are further distinguished into *flower-buds, leaf-buds,* and *mixed buds.* 1. The *flower-bud* or *fruit-bud,* is that which contains one or more flowers without leaves. It is generally pretty large, of an oval or rounded form; as in pear-trees and apple-trees. 2. The *leaf-bud* contains only leaves. Of this kind is the bud which terminates the stem of the common mezereon. 3. Lastly, the *mixed bud* is that which contains flowers and leaves together; as in the lilac.

Cultivators are never mistaken respecting the nature of a bud, which they easily distinguish in fruit-trees by its form. Thus, the bud which bears flowers is conical and enlarged, while that which bears leaves only, is slender, elongated, and pointed.

The *Turio.* The name of *turio* is given to the subterranean bud of perennial herbaceous plants, which, on being developed annually, produces the new stem. Thus, the part of the asparagus which we eat is the *turio* of that plant. The difference between the bud properly so called and the turio, is, that the latter always arises from a vivacious root, or a rhizoma; in other words, is of subterranean origin, while the bud always arises upon a part exposed to the air and light.

The *bulb* is a kind of bud belonging to certain perennial herbaceous plants, and particularly to the monocotyledones. It has already been stated, when describing the bulbiferous roots, that the bulb is supported by a kind of solid and horizontal plate, lying between it and the true root. To this flattened *tubercle,* the fleshy scales, of which the bulb is externally formed, are fixed by their base. The interior contains the rudiments of the flower-stalk and leaves. These scales become thicker, and more fleshy and succulent, the more internally they are situated in the bulb. The outermost, on the contrary, are thin and dry like paper.

Sometimes these scales are of one piece, and are enclosed within each other, or a single scale embraces the whole circumference of the bulb;

as in the common onion, cut 17, *f*, and the hyacinth. They are then named *coated* or *tunicated bulbs*. At other times, these scales are smaller, free at their sides, and cover each other only in the manner of tiles on a roof; as in the white lily, cut 17, *g*. Lastly, the coats are sometimes so close as to be confounded together, when the bulb seems as if formed of a solid and homogeneous substance. Bulbs of this kind are named *solid*, as in the common saffron.

Bulbs are generally of an oval or globular form. Sometimes, however, they are more or less elongated and even cylindrical; as is observed in some species of Allium. In the bananas the bulb is very elongated, cylindrical, and stem-like. They are sometimes *simple*, or formed of a single body; as in the tulip and squill. Or they are *multiple*, when several small bulbs are found collected under the same envelope; as in garlic.

Bulbs, being the buds of certain perennial herbaceous plants, are necessarily reproduced every year. But their regeneration does not take place in the same manner in all the species. Sometimes the new bulbs arise in the very centre of the old ones, as in the common onion; at other times, from the lateral part of their substance, as in meadow saffron; or the new bulbs are developed by the side of the old ones, as in the tulip and hyacinth; or above them, as in *gladiolus;* or beneath them, as in many species of *ixia*. In common language, the young bulbs are named *offsets*.

In proportion as a bulb shoots up the stem which it contains, the outer scales diminish in thickness, fade, and at length become perfectly dry. They consequently appear to supply the young stem with a portion of the materials necessary for its development.

Tubercles are true subterranean bulbs, belonging to certain perennial plants. They are sometimes *simple*, and develope only a single stem; as in the genus *orchis*. Occasionally *multiple*, that is, several together, each sending out a particular stem; as in *saxifraga granulata*. Sometimes *compound*, which is the case when several stems issue from a single tubercle; as in the potato.

The name of *bulbils* is applied to a kind of small solid or scaly buds, that grow on different parts of a plant, and are susceptible of vegetating by themselves; or which, when detached from the parent plant, become developed and produce a vegetable perfectly similar to that whence they derived their origin. Plants bearing buds of this kind are named *viviparous*. They may occur in the axilla of the leaves. At other times they are produced in the place of the flowers. The nature of the *bulbils* is similar to that of the *bulbs* properly so called. Sometimes they are *scaly;* at others *solid* and compact.

The small bodies developed in different parts of *agamic* plants, such as ferns, lycopodiaceæ, mosses, lichens, &c., and which have been improperly named *seeds*, must be considered as true bulbils. Although these bodies, to which we give the name of *sporules*, are capable of producing a plant similar to that from which they are detached, they cannot be confounded with true seeds. In fact, the essential character of the seed is that it contains an embryo, that is, a body complex in its nature, composed of a radicle or rudiment of a root, a gemmule or germ of the stem, and a cotyledonary body. By the act of germination, the embryo properly so called, merely developes the parts which already existed in it perfectly formed. Germination does not give rise to them; it merely places them in circumstances favourable to their growth. In the bulbils, on the contrary, and especially in the sporules of the agamic plants, there is no embryo. In them there is no trace of radicle, cotyledons, or gemmule. Germination creates these parts in them. They are not, therefore, true seeds.

Uses of Buds and Bulbs. Several kinds of buds are employed in domestic economy as food: such as the turios of asparagus, and of several other plants of the same family. Every one knows the daily use that is made of different species of the genus *allium;* such as the common onion, the garlic, the leek, and the shallot.

The bulbs or buds of some vegetables are also used in medicine. Thus it is of the buds of the *pinus picea* infused in beer that *spruce beer* is made. The scales of the bulb of the common squill furnish a powerful diuretic, and they are also employed as a stimulant to the pulmonary organs. Garlic is well known to be a cure for intestinal worms.

CHAP. IX.

THE LEAVES.

The leaves are the next organs to be considered. They are found on all the higher orders of plants, although many of the simpler kinds are entirely destitute of them. Before expanding into their full size, leaves are at first coiled up in a bud, as has been already explained. The manner in which leaves are thus coiled up, differs in the different kinds of plants. Sometimes they are folded up lengthwise into two halves, so that the margins of each side exactly coincide. Sometimes they are folded from above downwards, as in the aconite; at other times they are plaited like a fern, as in the common currant and vine, or rolled up in a spiral form, as in the apricot; the margin of the leaves being either rolled

inwards or outwards, or the leaf is rolled from above downwards, as in the family of ferns. Leaves are characterized as membranous, greenish coloured, and generally flat appendages, springing from twigs, branches, the trunk, or the neck of the root of plants. They generally lie with the plane of their surface in a horizontal direction. Their epidermis is porous, and their use is to absorb gases and moisture for the nourishment of the plant, and at the same time to exhale the moisture and gases which are superabundant. Leaves are formed of a net-work, of fibrous substance similar to that composing the stem, while the interstices are filled up with cellular tissue, or a soft greenish matter, similar to the herbaceous envelope which lies between the outer and inner bark of the stem.

Sometimes the body of the leaf is attached immediately to the stem, without any intermediate stalk, as in the common poppy, when, it is said to be *sessile*, fig. *b*.

26.

More frequently, however, there is a central stalk on which it is supported, which is called the *petiole*. In this case the leaf is said to be *petiolate*, as in the elm, lime, rosemary, &c., fig. *c*. This latter being the more general arrangement, the leaf may be considered as formed of two parts, the *petiole*, and the *disk* or *limb*; the latter being the generally flat and greenish part which constitutes the leaf properly so called. The petiole being wanting in many leaves, and the limb itself being also sometimes absent, through abortion; the leaf then consists of the petiole only, which frequently dilates and assumes the form and characters of a sessile leaf: as, for example, in all the simple-leaved acacias of New Holland.

In the leaf there are distinguished an *upper surface*, which is commonly smoother, more green, covered with a more closely adhering epidermis, and presenting fewer cortical pores; and a *lower surface*, of a less deep colour, often covered with hair or down, with an epidermis more loosely attached to the herbaceous layer, and presenting a great number of small holes, the orifices of the internal vessels of the plant. It is accordingly by their lower surface that the leaves absorb the fluids which are exhaled by the earth, or which are diffused and mingled in the atmosphere.

The lower surface of the leaf is also remarkable for numerous projecting prolongations running in different directions, which are merely divisions of the *petiole*, named *nerves*. One of these nerves, named the *mid-rib*, or *middle-nerve*, is nearly constant in its disposition, and forms the continuation of the petiole, having generally a longitudinal direction, and dividing the leaf into two lateral parts which are pretty frequently equal. From its base and sides proceed the other nerves, running in different directions, and frequently uniting with each other. The nerves assume different names according to their thickness, and the degree in which they project at the lower surface of the leaf. The *nerves*, properly so called, are prominent and very distinct; when they are less so, they are named *veins*; and the last ramifications of the veins, which intermingle frequently, and form the skeleton of the leaf, are called *venules*.

It must be observed that the *nerves* of plants have no resemblance in structure or functions to the nerves of animals. They are merely bundles of *porous vessels*, *spiral vessels*, and *false trachiæ*, enveloped in a certain quantity of cellular tissue. Sometimes the nerves are prolonged beyond the circumference of the *disk* of the leaf, and when rigid, form spines or thorns, more or less acute, as in the holly.

As the disposition of the nerves upon the leaves serves to characterize certain divisions of vegetables, they merit the greatest attention. Thus, in most of the *monocotyledones*, the nerves are almost always simple, very little branched, and with few exceptions, parallel to each other, as in cut 26, fig. *a*. In the *dicotyledones* they do not present this disposition; but they are frequently much ramified, and interlaced with each other.

The more remarkable varieties in the disposition of the nerves may be referred to the following:

A leaf, whether sessile or petiolate, may be attached, in various ways, to the stem or branches which support it. Sometimes it is simply *articulated*, and without directly uniting by the whole of its base, is simply fixed by a kind of contraction or articulation, as in the maple and horse-chestnut. These leaves are then *caducous*, or fall very early. At other times the leaf is so united to the stem, that it cannot be separated from it without being torn. Such leaves remain on the tree as long as the branch that supports them, as in the ivy.

27.

The manner in which *sessile* leaves are attached to the stem also deserves examination. Thus the middle nerve sometimes enlarges and embraces the stem in about half of its circumference. The leaves are then named *semiamplexicaul*.

The leaf is said to be *amplexicaul*, on the

other hand, when it embraces the stem in its whole circumference, as in the common goats-beard, and the white poppy.

Frequently also the base of the leaf is prolonged so as to form a sheath, which entirely surrounds the stem, and envelopes it for a certain length. In this case, the leaves are named *sheathing*, as in the wheat, oats, and grasses. This sheath may be considered as a very broad petiole, of which the two edges are occasionally united to form a kind of tube. The place at which the limb of the leaf and the sheath meet, is named the *neck*. Sometimes it is naked, at others furnished with hairs, as in *poa pilosa*, or with a small membraneous upper appendage, as is observed chiefly in the grasses.

Leaves of the same plant frequently differ in form, according to the part of the plant from which they arise ; hence they are *seminal leaves* when the cotyledons rise above the soil and assume the form of leaves. These will be alluded to when treating of the germination of seeds. In some plants the diversity of the leaves is very remarkable ; thus, ivy has some of its leaves entire, and others deeply lobed. Leaves also vary according to the medium in which they vegetate. Aquatic plants have generally two kinds of leaves; one set swimming at the surface of the water, or raised a little above its level; the other always immersed in this fluid. Thus, the water crowfoot has lobed leaves which float at the surface, and leaves divided into exceedingly narrow and very numerous segments, which are immersed in the water. *Radical* leaves are those which come off directly from the root ; *cauline*, or stem leaves, are attached to the stem, while branch leaves spring from the minuter ramifications. *Floral* leaves are those which accompany the blossoms.

28.

Leaves may be ranged opposite to each other in pairs, or alternate, coming off one by one, at nearly equal distances from different sides of the stem. *Verticillate* or whorled, when more than two come off together, thus forming a circle around the stem, as in the *galiums*. Sometimes the leaf entirely surrounds the stalk, when it is called perfoliate, *d*.

29.

d

The *Frond* consists of a union, or incorporation of the leaf, leaf-stalk, and branch or stem, forming, as it were, but one organ of which the constituent parts do not separate spontaneously from one another, by means of the fracture of any natural joint, as in the case of plants in general ; but adhere together even in their decay. The leaf of the palms was termed a frond by Linnæus ; and that of the ferns go under the same name. The algæ and lichens consist, for the most part, of fronds only.

Leaves are of various shapes, and have received names accordingly; as, orbicular, oval, oblong, lanceolate, linear, awl-shaped, filiform, cordate or heart-shaped, reniform, or kidney-shaped, sagittate, hastate. Leaves may also be deeply notched, so as to be divided into three or more lobes, hence they are called *tripartite, quadripartite.* Pinnatified, divided into deep lobes along the sides. The following figures will show the most striking diversities of the form of leaves.

30.

Oboval. Acute. Hastate. Sagittal.

Pinnatified. Laciniate. Retuse. Emarginate.

Cordate. Tripolate. Lanceolate. Linear. Orbicular.

Trilobate.

Leaves are also called *entire,* when the margin is even; *dentate,* when the margin is marked by erect teeth. *Serrate,* when the teeth are inclined to the summit of the leaf, like the markings of a saw. *Doubly serrate,* when each small tooth is itself serrated. *Spinous* with acute thorns, or spines, as in the holly and thistle. *Ciliated,* having the margin furnished with hairs. Leaves are also distinguished by their external surface into shining, smooth, coreaceous or leathery, glutinous, fleshy, glaucous, or sea green, spotted, &c.

Compound Leaves. When several leaves are attached to a common petiole, they are said to be compound, fig. *e.* If the petiole branches out into several parts, and each part contains a set

of compound leaves, they are then called *decompound*, or *doubly compound*, fig. *f*. The simply

31.

e *f*

compound leaves have two principal modifications, depending on the position of the leaflets that compose them. Thus, sometimes all the leaflets proceed from the very top of the common petiole, as in the horse chestnut, and trefoil; sometimes again they spring from the sides of the common petiole, as in the ash, bladder senna, &c. The name of *digitate* has been given to the former, and pinnate to those of the latter. Digitate leaves, then, are those which spring in a divergent manner from the top of the common petiole, like the fingers of the hand spread out. They are *unifoliate*, as in the leaf of the orange tree; *trifoliate*, as in wood-sorrel, quinquefoliate, as in potentilla, &c.

Pinnate, leaves arranged on each side of a common petiole, like the barbs of a feather in the shaft.

Decompound, where the common petiole is subdivided into other petioles, being compound leaves, as in mimosa, fig. *g*.*

32.

g *h*

Supradecompound, are those in which the secondary petioles are divided into tertiary petioles, bearing leaflets, fig. *h*.

We now proceed to explain the functions of these essential organs of plants.

Leaves, as before observed, are formed of three principal parts, namely, a bundle of vessels coming from the stem; cellular substance, which is a prolongation of the herbaceous envelope of the bark; and, lastly, an outer skin or epidermis, by which they are covered in their whole extent.

The bundle of vessels constituting the petiole, when this organ is present, consists of tracheæ, false tracheæ, and porous vessels. They are externally enveloped by a layer of the herbaceous substance, which is prolonged over them when they come off from the stem. By their expansion and successive ramifications, they form the network of the leaf. The meshes or empty spaces which they leave between them are filled with cellular tissue coming from the bark. This tissue is sometimes wanting, as when the leaf consists of vascular network alone, presenting the appearance of a kind of lattice-work or lace.

The epidermis which covers the surface of the leaf is generally thin and very porous, especially on the under side. The two layers of this organ, seen upon the upper and under surfaces of the leaf, cover the part which is formed by the vascular fibres and cellular tissue. This organ is very thin, in flat and membranous leaves; but in such as are thick and fleshy, as those of succulent plants, it is greatly developed, and gives the leaf its form.

The *stomata* or pores which are observed on leaves, are, according to some authors, nothing but the upper orifices of the sap-vessels; while others maintain that they transmit air.

The leaves and roots are the principal organs of absorption and nutrition in vegetables. The former absorb from the atmosphere the substances which are subservient to growth, and hence they have been called *aërial roots*. They are also subservient to other purposes of great importance in the economy of plants. They transpire and exhale the fluids which have become useless to vegetation, and it is by their agency that the sap is freed of the watery juices which it contains, and acquires all its nutritive qualities.

It is chiefly by the pores situated on the lower surface of the leaves of woody plants that the watery vapours and gases diffused in the atmosphere are absorbed; and hence this surface is softer, and less smooth than the upper, and is generally covered by a light down which is favourable to this absorption; while the upper surface, on the contrary, is smoother, generally glabrous, and throws off the fluids which are useless for the nutrition of the plant. This excretion is named *transpiration* in vegetables.

The leaves of herbaceous plants, being nearer the ground, and immersed in a constantly humid atmosphere, absorb equally by both surfaces. The knowledge of this fact we owe to the celebrated Bonnet. The most complete set of experiments, upon the absorbent power of the leaves, is detailed by that naturalist. Satisfied that leaves are furnished with absorbent organs for the purpose of taking in moisture, his object was that of ascertaining whether the absorbent power of both surfaces was alike. With this view he filled several vessels with water, on the

* Particular explanations of all the terms will be found in the glossary at the end of this work.

top of which he placed a number of leaves, some having the upper, and others the under surface applied to the water, so as that they only floated in it, but were not immersed. If the leaf retained its verdure longest with its upper surface applied to the water, the absorbing power of the upper surface was to be regarded as the greatest; but if it retained its verdure longest with the under surface applied to water, then the absorbing power of the under surface was to be regarded as the greatest. The experiment was made in the spring and autumn, the temperature being between five and ten of Reaumur, and the leaves employed being such as were fully expanded. The result was as follows. Out of fourteen herbs, of different families, selected for the purpose of experiment, the leaves of six—the wake-robin, kidney bean, sun flower, cabbage spinach, and small mallow, were indifferent to the mode in which they were applied to the water, and were found to retain their verdure equally long, whether moistened by the upper or under surface. The rest, the plantain, white mullein, great mallow, nettle coxcomb, purple leaved amaranth, marvel of Peru, and balm were not indifferent to the mode in which they were applied to the water, but retained their verdure longest when moistened by the upper surface. The following are the most remarkable examples of the relative capacity of the different surfaces. The leaf of the nettle, when moistened by the upper surface, lived two months; but when moistened by the under surface, only three weeks. The leaf of the amaranth, when moistened by the upper surface, lived three months; and when moistened by the under surface, only seven or eight days. The leaf of the mullein, when moistened by the upper surface, lived five weeks; and when moistened by the under surface, only five days. A leaflet of the French bean absorbed also a sufficient quantity of moisture to nourish another leaflet that was still attached to the same footstalk, though not touching the water. Out of sixteen trees, or shrubs, of different kinds, selected for the purpose of experiment, the leaves of only two, the lilac and aspen, retained their verdure equally long, by whatever surface they were moistened. But the leaves of the others; the vine, pear, cherry, prune, apricot, walnut, mulberry, oak, hazel, rose, &c., retained it longest when moistened by the under surface. The following are the most remarkable examples of relative capacity. The leaves of the white mulberry, when moistened by the under surface, retained their verdure for nearly six months; but when moistened by the upper surface, they retained it for only five or six days. The leaves of the vine, poplar, walnut, faded almost as soon when moistened by the upper surface, as when left without water altogether. The leaves of the hazel and rose, when moistened by the under surface, absorbed a sufficient quantity of moisture to nourish also other leaves on the same branch, though not touching the water. But as the foregoing experiments on leaves were made on such only as were detached from the plant, it may be said that they are not well calculated to become the ground of any general conclusion; and that they do not represent to us what actually takes place in growing vegetables. But if we appeal to the actual facts which take place in nature, we shall find that they are confirmatory of the above experiments. If after a long drought a fog happens to take place before any rain fall, so as to moisten the surface of the leaves, the plant begins to revive, and to resume its verdure long before any moisture can have penetrated to the root. Hence, it follows incontestibly that moisture has been absorbed by the leaf, because it is impossible to account for the change that has been effected, except by such absorption. But the efficacy of rains themselves, and of artificial waterings, may be accounted for upon the same principle; for they have not always penetrated to the root when they are found to have given freshness to the plant; and, indeed, many plants will thrive merely by having their leaves kept moist, though no water should reach the root at all. The same thing might be said of the immersed *fuci*, many of which, being totally destitute of root, and constituting merely a sort of frond or leaf, absorb the nourishment necessary to their support by the whole of their surface. The moisture then entering the plant as food, is taken up by means of the absorbent pores of the epidermis, not only of the root and leaf, but often, as may be presumed, of the other parts of the plant also, at least when they are in a soft and succulent state. Bonnet has shown that most leaves absorb moisture better by the one surface than the other; and it is known that some surfaces do actually repel it, as may be seen in the leaves of the common cabbage, after a fall of rain or dew, when the drops roll along the upper surface without wetting it, or lodge in its folds and hollows, like globules of quicksilver. This is the case also with all such plants as are covered with bloom. It is probable, therefore, that all such surfaces as repel moisture, are fitted rather for the inhalation of air. Grew first established the importance of air to the life of plants, and conjectured that it was absorbed by the leaf. Papin, with a view to ascertain the point in question, introduced into the receiver of an air pump an entire plant, root, stem, and leaf. The consequence was, that on the exhaustion of the air, the plant very soon died. He then introduced a plant by the root and stem only, while the leaves were still exposed to the influence of the air. In this case, the plant lived much longer than in the former, and warranted him, as he

thought, to conclude that leaves are equivalent to the lungs of animals. Another argument in support of the doctrine was deduced from Du Hamel's experiment of besmearing the surface of the leaf with oil, in consequence of which treatment it soon died, owing, as it appeared, to the exclusion of air. Modern chemistry has afforded us many other proofs of the functions of the leaves of plants. The experiments of Priestley, Ellis, Decandolle, and others, have fully established both the absorption and exhalation of gases through the medium of the leaves.

From some recent experiments also it appears that vegetables, by decomposition of moisture, can supply an atmosphere to themselves; and thus, that plants will grow and thrive when inclosed in glass cases, perfectly impervious to external changes of atmosphere, simply by decomposing the water of the moist soil, with which they are furnished.*

The decomposition of the carbonic acid absorbed from the air is effected in the parenchyma of the leaves, as well as in all the other green and herbaceous parts of the vegetable. When vegetables are exposed to the action of the sun, they are decomposed, the air retaining the carbon, and disengaging the oxygen. The reverse takes place when they are withdrawn from the influence of light, in which case they extract from the air a portion of its oxygen, which they replace by disengaging an equal quantity of carbonic acid gas. It is well known that vegetables, when removed from the influence of the sun, become blanched; in other words, lose their green colour, are rendered soft and watery, and contain a larger proportion of saccharine principle. But we shall speak more particularly of the phenomena of absorption and transpiration, when we come to treat of nutrition in plants.

The leaves are susceptible of certain motions evidently depending upon the irritability of which they are possessed. This property in plants is clearly established by numerous and authentic facts. If a branch, still attached to its stem, be so placed that the lower surface of the leaves is turned upwards, these will be seen to turn gradually round and resume their natural position. This fact may be daily observed in pruning and palisading espaliers; such as the peach, the vine, &c.

Compound and articulated leaves, or those whose leaflets are attached by a joint to the common petiole, present the most remarkable motions. Thus the leaflets of many legumines, whose leaves are all articulated, have a different position at night from that which they occupy in the day. Linnæus called this singular phenomenon the *sleep of plants*. The leaflets of the acacia, for example, are extended nearly in a horizontal direction at sunrise; but as the day advances, they gradually rise, and at length become almost vertical, falling again as the day declines. Other plants present similar phenomena, depending upon the influence of light, as may be inferred from the ingenious experiments of Decandolle. That excellent botanist having placed some plants with compound leaves in a dark cellar, changed their hours of sleeping and waking, by depriving them of light during the day, and exposing them to a strong light at night.

The leaves of certain plants also perform motions depending upon irritability, and which cannot be attributed to the influence of light alone, as in the sensitive plant. The slightest shock, the least agitation of the air, the shadow of a cloud or of any other body, the action of the electric fluid, heat, cold, irritating vapours, such as chlorine, or nitrous gas, each of these is sufficient to cause its leaflets to perform the most singular motions. If one of them be touched, it raises itself against the one which is opposite to it, and presently all the other leaflets of the same stalk perform a similar motion, until at length they cover each other like tiles on the roof of a house. The leaf itself soon after bends towards the ground. But, in a short time, if the exciting cause has ceased to operate, all these parts which seemed withered, resume their natural aspect and position.

That singular plant the *hedysarum gyrans*, which is a native of Bengal, presents very remarkable motions. Its leaves are single, and have two small lateral stipules. The two stipules perform a twofold motion of bending and twisting upon themselves, which in the one appears to be independent of that of the other; for one of them sometimes moves with rapidity, while the other continues at rest. This motion takes place without the intervention of any external stimulus, and is not suspended at night. The motion of the leaflet, on the contrary, appears to depend upon the action of light, and ceases when the plant is withdrawn from it.

33.

The fly-trap (*Dionæa, Muscipula,*) a native of North America, has two lobes connected by an intermediate hinge, at the extremity of its leaves. When an insect or any other body touches and irritates one of the small glandular bodies which are observed on their upper surface, the two lobes quickly rise, approach each other, and seize the insect by which they were irritated. From this circumstance, the plant has received the vulgar name of *fly-trap*. But it

* The apparatus for this purpose shall be described afterwards.

is to be remarked, that the only irritable parts in this leaf are the two or three small glandular points which are observed on its upper surface.

The movements of plants, unlike those of the higher orders of animals, are effected by organs situated in the part where the movements take place. In the collar of the sensitive plant there is nothing similar to muscles; yet, while the collar is the seat of motion, as is shown by its incurvations when the leaves are irritated, it is at the same time the seat of mechanism, by which motion is effected. In the sensitive plant there is a long leaf stalk, the base of which swells out into an oval collar, and a similar, but smaller collar, surrounds the base of each pinnula where it joins the leaf-stalk, and also each leaflet at the point of its attachment. The centre of the collar is a bundle of vascular tubes, around which is formed a structure consisting of numerous oval transparent bags, dispersed through a cellular tissue, with minute corpuscles intermixed. If all the spongy part of the collar be removed from around the central bundle of vessels, the footstalk no longer bends when the leaf is irritated; if the lower half only of the collar be removed, the footstalk bends, but cannot be restored to the erect position; when the irritating curve is withdrawn, and if the upper half only be removed, the footstalk remains always unnaturally erect, and does not tend down as usual in the dark, or on the application of external stimuli. Hence the motions of the sensitive leaf are effected by an organic action of the half of the collar, opposite the side towards which incurvation takes place. The movements of the two pinnulæ on the leafstalk, and of the several pairs of leaflets in each pinnula, are affected by the same kind of mechanism and actions. This action is in its nature intimately connected with the afflux of sap; for where a proper supply of moisture is withheld, stimuli fail to excite motion, and when a slice of the collar is immersed in water, it immediately bends itself towards what was the side next the centre of the leafstalk. This movement and the whole action of the collar depends, according to Dutrochet, on the cells becoming tinged with sap, according to his theory of *endosmose*, which will be explained when treating of the motions of the sap. It may be sufficient to explain here, however, that in all cases where the incurvation of vegetable leaves, or stalks, or tendrils occur, it has been found, that the part where the incurvation takes place, is supplied with *vesicular corpuscles*, as Dutrochet terms them, diminishing in magnitude from the convex to the concave side of the curve, the effect of which structure must be, that when the part is supplied with a fluid less dense than the contents of the *corpuscles*, the larger bodies become most turgid by the flow of sap into them. Incurvation to the opposite side must therefore be always produced in such circumstances. There is little difficulty, then, in comprehending how the afflux of sap into the side containing the larger cells, causes incurvation of the opposite side inwards; in fact if a thin slice of it be immersed in water, it immediately bends towards the side which was next to the centre of the leafstalk; and if it be, on the contrary, immersed in a heavier fluid, as strong syrup, it unfolds itself, and bends over to the opposite side. These facts explain sufficiently the mechanism by which the movements of the sensitive plant are produced, but they do not throw any light on the power which external stimuli have in exciting this mechanism; they do not determine why the flow of the sap causes the incurvation of the upper spring of the collar to predominate over the lower, when the leafstalk bends downwards, or why after a little repose the lower spring resumes its predominance, and raises the leafstalk.

Fall of the Leaves. A period arrives every year, when most vegetables are stripped of their leaves. It is commonly at the end of autumn, or the beginning of winter, that trees lose their foliage. But the occurrence does not take place at the same period in all plants. It is observed, in general, that the trees whose leaves are earliest expanded, are also those which lose them first, as is seen to be the case with the lime, the horse-chestnut, &c. The elder forms an exception to this rule; for its leaves appear at an early season, and are very late in falling. The common ash presents another peculiarity: its leaves are very late in coming out, and fall at the end of summer.

Petiolate leaves, and especially those which are articulated upon the stem, detach themselves sooner than those which are sessile, and still more so than those which encircle the stem. In general, in herbaceous plants, whether annual or perennial, the leaves die along with the stem, without previously separating. Plants which annually shed their leaves are termed *Deciduous*. On the other hand there are trees and shrubs which remain always adorned with their foliage; these are the resinous species, such as pines and firs, or certain vegetables whose leaves are stiff and leathery, as the myrtles, alaterni, rose-laurels. These are named *Evergreen* trees.

Although the fall of the leaves generally takes place at the approach of winter, cold is not to be considered as the principal cause of this phenomenon. It is much more natural to attribute it to the cessation of vegetation, and the want of nourishment which the leaves experience at that season, when the course of the sap is interrupted. The vessels of the leaf contract, dry up, and, soon after, that organ is detached from the twig on which it had been developed.

The various tints of the autumnal leaf, such as

yellow, red, brown, are owing to the different degrees of oxidation of the matters contained in the desiccated juices of the leaf; not unfrequently the colour is influenced by numerous minute fungi which spring up on the surface of the decaying leaf. How beautiful are the mellow tints of an autumn forest! more deep and gorgeous, though not so full of hope and joy, as the light budding appearance of spring. A late traveller thus remarks of the foliage of the southern hemisphere:

"In South America, Australia, and the Cape of Good Hope, the trees are all evergreens. The inhabitants of these and the intertropical regions generally, thus lose, perhaps, one of the most glorious, though to our eyes common spectacles in the world, the first bursting into full foliage of the leafless tree. They may however say, that we pay dearly for our spectacle by having the land covered with mere naked skeletons for so many months. This is too true, but our senses thus acquire a keen relish for the exquisite green of the spring, which the eyes of those living within the tropics, sated during the long year with the gorgeous productions of those glowing climates can never experience." *

The size of the leaf, as well as all the other qualities, varies according to the species of plant on which it grows. Nor is it always the largest plant that has the largest leaf. The leaf of *Caltha palustris*, an humble herb, is larger than the leaf of the oak, though a lofty tree. The largest leaf produced on any British plant is that of the *Tussilago petasites*, and yet it is diminutive compared with the leaves of many plants of tropical climes. The leaf of *Strelitzia regina* grows to the height of three or four feet, and is eighteen inches at its greatest breadth, yet there are many still larger. The leaves of the magnificent banana have been known to grow to the extent of ten feet in length, by two feet at the base; hence some fancy writers have set them down as the leaves which our first parents employed to clothe their nakedness. The leaves of some of the palms are from ten to fifteen feet in length, and even the smallest leaflets are three feet. A tree in full foliage affords a most grateful shade both to man and animals, especially under tropical suns, where indeed the foliage is largest and most luxuriant; even in temperate regions, the cool canopy of a wide spreading tree, and the pleasing and refreshing green of its foliage, are grateful luxuries during the heats of summer. Hence the fame of the celebrated groves of Arcadia, where Plato and his successors delivered their lectures in philosophy; and the cool and shady, though less classical avenues, of lime and chestnut trees of our own country. The odour of some leaves is extremely grateful, particularly when bruised with the hand, as the myrtle, balm, thyme, and many others. Some leaves retain this aromatic flavour for several years, even in a dried state, as is the case of verbena and lavender. The leaves of many of the geranium tribe are extremely sweet scented, and the odour of many others are well known.

The leaves of certain vegetables are extensively used as articles of food, such as cabbage, lettuce, celery, parsley; and cultivation has greatly altered and inhanced them as dietetic substances. The grasses, and every species of green herbage, also form the food of a large proportion of animals. There is scarcely a leaf of almost any species of plant but what is not appropriated as the food of certain insects. Leaves are also used as medicines; such are the leaves of foxglove, senna, and others.

* Darwin's Natural History of a Voyage to South America.

CHAP. X.

THE STIPULES.

The *Stipules* are organs connected with the leaves, existing only in the dicotyledonous plants, though not always present. They are small scale-like or leafy appendages, at the point where the leaves come off from the stem, and are commonly in pairs, there being one on each side of the petiole, as in the hornbeam and lime. They are more frequently free, not being attached to the petiole; but, at other times, they are united to the base of that organ, as in the genus *Rosa*.

The Stipules afford excellent characters for the arrangements of plants. When a vegetable of a natural family has these organs, it is very seldom the case that all the others are not equally provided with them. Thus they exist in all plants of the families of *Leguminosæ*, *Rosaceæ*. *Tiliaceæ*, &c. As they fall off very easily when they are free, their absence might sometimes induce one to suppose a plant destitute of them; but this error may easily be avoided by observing that they always leave on the stem, at the place where they were attached, a small cicatrix, or scar, which attests the fact of their having existed.

In the coffee, cinchona, and other similar plants, the stipules are situated between the leaves, and appear to be nothing more than abortive leaves. In fact, in the same family of our climates, such as the galiums, they are substituted by true leaves, which then form a whorl around the stem. Some plants, as the barberry, have single stipules. Where there are two, they are always distinct from each other; but sometimes they unite and are *connate*, as in the hop. The stipules may be united within the axil of

the leaf, between the stem and the petiole, in which case they are said to be *axillar*, as in *Melianthus major*. The stipules vary greatly in their nature and consistence. Thus they may be *foliaceous*, or similar to leaves, as in the common agrimony; *membranous* as in the fig and magnolia; *spinescent*, or thorny, as in the jujube and the gooseberry.

With respect to *duration*, some fall off before the leaves; as in the common fig and the lime. Others are merely *caducous*, or fall at the same time as the leaves, as is the case in the generality of plants. Lastly, there are others which continue for a longer or shorter time after the leaves have fallen; as in the jujube, the gooseberry, &c.

The use of the stipules appears to be to protect the leaves before their expansion, as is evidently shown by their relative disposition in the buds of some families of plants.

34.

a b

The Tendrils or Cirrhi. These are certain appendages, fig. *a*, *b*, generally filamentous, situated on different parts of the plant, simple or branched, and which twist themselves, in a spiral form, around neighbouring bodies, thus serving to support the stem of weak and climbing plants.

Tendrils are in all cases abortive organs. Sometimes, they are floral peduncles, which have been greatly elongated, as in the vine, and are occasionally seen to bear flowers and fruits; sometimes they are formed of petioles; and at other times they are altered stipules, or even abortive twigs. Not unfrequently, the leaves themselves are rolled up at the extremity, and thus constitute a kind of tendrils, as in the pink. The relative position of the tendrils deserves to be carefully attended to, as it indicates the organ for which they are substituted. Thus in the vine they are, like the clusters of flowers, *opposite* to the leaves, which shows them to be abortive clusters. They are *axillar* in the passion-flowers; *petiolar* in *lathyrus latifolius* and *fumaria vesicaria; peduncular* in the vine; *stipular* in certain species of *smilax*. Lastly, they may be *simple*, as in *bryonia alba*, or *branched*, as in *cobœa scandens*.

The name of *claspers* is given to the kind of roots which climbing plants sink into the bodies on which they raise themselves, as in the ivy; while that of *suckers* is given to the very slender filaments which are met with on the surface of claspers, and which appear to be destined to absorb the nutritious parts contained in the body into which they are inserted.

Spines or *thorns d*, are sharp-pointed organs, formed by the prolongation of the internal tissue of the vegetable; while *prickles c*, originate only from the most external part of plants, that is, from the epidermis, from which they may be detached with the greatest ease.

35.

c d

The origin and nature of the spines are not less variable than their seat. They are substituted for the leaves in certain African species of asparagus, and for the stipules in the jujube and the gooseberry. Very frequently they are merely abortive twigs; as in the sloe, which, on being transplanted into a good soil, changes its spines into twigs. The trunk of some trees is so covered with spines as to render them inaccessible. According to their situation and origin, they are *cauline*, when they spring from the stem; as in the *cactus: terminal*, when they are developed at the extremity of the branches and twigs; as in the sloe*: axillar*, when they are situated in the axilla of the leaves; as in the citron*: infra-axillar*, when they spring from beneath leaves or twigs; as in the gooseberry.

Prickles have been considered by some physiologists as indurated hairs. They adhere but slightly to the parts on which they are observed, and may easily be detached from them, as is seen in the rose. The modifications which they present with respect to situation, form, &c. are the same as in the spines.

Among other appendages of plants, may be mentioned the singular cup of the *nepenthes distillatoria*, or pitcher plant. Attached to the extremity of its long slender leaf, is a body exactly resembling a water pitcher, furnished with a lid or covering, which opens and shuts according to the absence or presence of the sun, or the degree of heat. In this cup is contained a quantity of pure water, secreted from the juices of the plant. What purpose this secretion serves in the economy of the particular vegetable, has not been ascertained; a more particular account of the plant will be given afterwards.

CHAP XI.

NUTRITION OF VEGETABLES, AND ASCENT OF THE SAP.

We have now finished the description of the organs which contribute to the nutrition of the plant, including the roots, stem, and leaves, with the various minute cells and vessels of which

they are composed. It remains now to explain the manner in which the nutritive matters are taken into the plant, and thence circulated and elaborated, so as to become part of the organized structure of the vegetable. In this description, however, we shall confine ourselves at present chiefly to the course of the juices in the sap vessels; as after describing the remaining organs of plants, we shall have to return to the physiology of vegetation, properly so called.

A plant then, as we have seen, is an organized body, with a variety of structure suited to the various purposes of nutrition. Before it can exhibit the phenomena of life, and grow, and increase in bulk, certain external stimuli are necessary. These are, in the first place, a supply of certain nutritious matters held in solution by water, or in the form of gas or air. The other stimulants are heat, light, and electricity. Water is the necessary vehicle of the nutritious substances of plants; but it is also decomposed, and its constituents, hydrogen and oxygen, enter into their composition. It is not the sole nutriment of these, however, as was supposed by the older naturalists; for if a plant be made to vegetate in pure or distilled water, without access to any other substance, it will soon perish. Carbon, silex, lime, soda, potass, the oxides of iron, and some other metals, all enter into the vegetable structure through the medium of the moist soil. The air of the atmosphere also affords oxygen, both in its simple state and combined with carbon, forming carbonic acid. Nitrogen, the other ingredient of the atmosphere, also enters in small proportion into their substance.

Various experiments have been instituted, to show that plants really obtain the various matters of which they are composed, from the soil and atmosphere. Thus, two grains of buckwheat were made to germinate in a little pure sulphur, placed in a platina cup, and moistened with distilled water, over which was put a glass bell, the more carefully to exclude all foreign matters. In the course of a few days the seeds germinated, and at the end of a fortnight had thrown out roots and leaves. The whole was now collected and analysed, and their product exhibited exactly the same proportion of phosphate and carbonate of lime, and silex, that the same weight of other similar seeds contained, which had not been subjected to germination.

Before proceeding to detail the various experiments illustrative of the absorption and ascent of the sap in vegetables; we shall shortly describe the process as it is now supposed to take place according to the most recent investigations; and for this purpose we shall use the annexed diagram.

The juices of the moist soil are absorbed by the roots *a a*, by means of minute spongioles attached to the extremities of these roots. This watery fluid having entered by the roots, mingles with the sap already in the stem of the plant,

23.

and mounts upwards by vessels near the central parts of the woody fibre surrounding the pith, as represented by the dotted lines *b b*; having traversed the trunk it then enters the branches, and at last reaches the leaves; here it combines with air absorbed from the atmosphere, through the pores or stomata of the leaves, *c c*. It here also gives off its superfluous water, and altogether becomes a different kind of fluid from what it was in its ascent. It now constitutes the proper juice or nutritious fluid of the plant, and again descends from the leaves, through a series of simple tubes in the liber or bark *d d*, and then is deposited so as to form new wood bark, and other parts of the plant. Such is the process which has been called the circulation of the sap.

We are indebted to the celebrated natural philosopher Hales, for demonstrating by the most accurate and ingenious experiments the prodigious power of suction, of which the roots and branches are possessed. He exposed one of the roots of a pear-tree, cut off its extremity, fitted to it one of the ends of a tube filled with water, having the other end immersed in a mercurial trough, and in six minutes the mercury rose eight inches in the tube. To measure the force with which the vine absorbs humidity in the ground, Hales made an experiment, the results of which might appear inaccurate and exaggerated, had they not been verified of late years by Mirbel, who repeated the experiment. The English philosopher, on the 6th of April, divided a vine shoot without twigs, of about seven or eight lines in diameter, and at a height of thirty-three inches above the ground. He then fitted to it a doubly bent tube, which he filled with mercury up to the curve which surmounted the transverse section of the stem. The sap which

issued had sufficient force to raise the column of mercury thirty-two inches and a half above its level, in a few hours. Now, the weight of a column of air of the height of the atmosphere is equal to that of a column of mercury twenty-eight inches high, or of a column of water of the height of about thirty-three feet. In this case the force with which the sap rose from the roots into the stem, was much greater than the pressure of the atmosphere.

Many facts and experiments demonstrate the office which the leaves perform in the phenomena of suction and absorption. Thus, a branch detached from the tree of which it formed part, still absorbs with great power the fluid in which its extremity is immersed. The same action takes place when it is turned upside down, and its summit is immersed in the water, its absorbent power suffering no diminution. In summer, we see that the heat of the sun causes the plants which ornament our gardens to shrivel and fade; but when we examine them at night or in the morning, we find that the dew which the leaves have absorbed has restored their freshness and vigour.

If a plant be entirely stripped of its leaves, it will soon perish, because the absorption which takes place by the roots is insufficient to supply all the materials necessary for its nourishment.

In many vegetables, and particularly in the genus *cactus*, and other succulent plants, whose roots are very small, and which commonly vegetate on rocks, or in the shifting sands of deserts, it is evident that the absorption of the nutritious fluid is almost exclusively performed by the leaves and the other parts exposed to the atmosphere; for the smallness of the roots, and the extreme dryness of the soil in which they grow, would otherwise prevent them from vegetating. From what has been said, it will be seen that the absorbent surface of vegetables, compared with their general volume, is incomparably greater than in animals.

Course of the Sap. The *sap* is the colourless and essentially watery fluid which the roots absorb in the earth, and the leaves in the atmosphere, for the purpose of supplying nourishment to the plant. It contains in solution the true nutritious principles, and deposits them in the interior of the plant, as it passes through its tissue.

The older physiologists were long in doubt respecting the part of the stem through which the ascent of the sap takes place; some believing it to be the pith, while others considered the bark as the seat of this singular phenomenon. But when recourse was had to direct experiments, it was shown that both these opinions were alike erroneous. In fact, the course of the sap is performed through the woody layers. The lymphatic vessels distributed in the wood and alburnum, serve as canals for the transport of this nutritive fluid; and the part nearest the medullary tube appears to be the principal seat of this ascent. If a branch, or a young plant, be immersed in a coloured liquid, the traces of the absorbed fluid may be followed, especially in the vessels near the medullary tube, whereas none of it will be seen either in the pith or in the bark. Coulon accidentally discovered this fact. He had a row of large poplars cut down, when in one of them which had been circularly sawn, and had fallen, but which still held to the stump by its centre, he saw bubbles of liquid and air rising from the inner fibres, and emitting a very distinct sound. He then tried some experiments on the trees which still remained to be cut down. Thus, on having them bored with a large auger, he found that the fragments which were taken from the outer layers of the wood were nearly dry, that they became moister as the auger went deeper, and that when it had arrived at the centre of the stem, the sap began to flow out at the surface. These experiments were laid before the Academy of Sciences, and Desfontaines and Thouin, who repeated them, confirmed their accuracy. This fact then, evidently proves that the ascent of the sap takes place in the woody layers, and especially in those which are nearest the medullary canal. It has also been shown by experiment, that the progress of the sap is not arrested in trees deprived of their bark, and in which the pith is more or less obstructed; while in trees from which all the woody layers are removed, it no longer takes place, although, in such as have only a small cylinder of woody layers remaining, the sap may still continue to ascend, as is the case in hollow trees, and especially willows, the trunk of which is very frequently carious in the interior.

In thus passing through the layers of the wood, in its progress upwards, the sap communicates with the lateral parts and branches of the stem, either directly by junction of their vessels, or by gradually diffusing itself through the minute pores with which the canals that transport it are perforated. The water, which forms the essential basis of the sap, gives off in its progress, and deposits in the vegetable tissue, that matter with which it is impregnated, and which is destined for the nutrition of the plant, and the reparation of its expended fluids.

When treating of the suction of the roots, we mentioned the experiments of Hales, proving the force with which the ascent of the sap takes place in a stem even of small diameter, it acting with more power upon the mercury than a column of air equal to the height of the atmosphere. Bonnet has also made experiments for the purpose of determining the rapidity with which the sap may rise. Thus, on immersing two stalks of the kidney bean in coloured fluids,

he found that the latter rose sometimes half an inch in half an hour, sometimes three inches in one hour, and sometimes four inches in three hours.

From the observations and experiments of Professor Amici, it would appear that the fluids contained in the vessels, or in the areolæ of the cellular tissue of plants, move and circulate in each of these vessels or cells, quite independently of the manner in which they move in the others. Each cavity, he says, constitutes a distinct organ, and in its interior the fluid moves in a circulating manner, independently of the particular circulation which takes place in each of the adjacent cavities. It was chiefly on *Chara vulgaris*, *Ch. flexilis*, and *Caulinia fragilis*, aquatic plants whose organization is more easily perceived on account of the transparency of their elementary parts, that Professor Amici made his observations. The motion of the fluid in each cavity of the cellular tissue, or in each vessel, may be distinctly perceived, on account of the solid particles which float in the fluid. These particles, which are globules of extreme minuteness, and sometimes of a very decided green tint, are seen ascending along one of the walls of the cavity, and, on arriving at the horizontal partition which separates the cell from the one above it, changing their direction, and following a horizontal course until they reach the opposite wall, when they descend along it to its lower part, where their course again becomes horizontal; after which they recommence the same route. In the same vessel there are thus always four different currents, an ascending, a descending, and two horizontal ones, in opposite directions. It is very remarkable that the direction of the motion in each vessel does not seem to have any connection with that which takes place in the neighbouring tubes. Thus sometimes two vessels in mutual contact present the same motion, while, in those which surround them, a directly opposite motion is observed in the fluids.

The same observer has also remarked, that no globule is seen passing from one cavity into another. "However," says he, "I do not pretend to maintain that the fluid contained in a vessel, does not, when circumstances require it, penetrate into the neighbouring vessels. I am even persuaded that this transfusion is necessary for the development of the plant; but it is only the most fluid and subtile part of the juice that can penetrate through the membrane invisibly, by passing through holes which the eye, assisted by the microscope, is unable to perceive."

Some have attributed the cause of this independent motion of the fluid, to the irritability possessed by the membrane of which the tubes are formed. Professor Amici is not of this opinion; but thinks he recognises the moving power of the fluid in the small green or transparent grains lining the walls of the tubes where they are disposed in rows, and which, by an action similar to that of the voltaic piles, produce the motion of the fluid. These green grains are evidently the same as those which Dutrochet considers as the nervous system of vegetables.

But what is the cause of this ascent of the sap? How can that fluid rise from the roots to the upper part of the stem? It may well be supposed that each of the older physiologists must have had an opinion of his own to account for this surprising phenomenon.

Grew attributed it to the action of the utricles. That author, who considered the vegetable tissue as formed of small utricles, placed in juxta-position, one above another, and all communicating together, thought that when the sap had once entered into the lower utricles, they contracted upon themselves, and pushed it into those immediately above; and that, by this mechanism, the sap at length reached the summit of the plant. Malpighi, on the other hand, attributed the ascent of the sap to its alternate rarefaction and condensation by heat. De La Hire, who supposed the sap-vessels to be furnished with valves, like the veins of animals, thought that it depended upon this arrangement. Perault imagined it to be produced by a kind of fermentation. Lastly, many persons have compared the progress of the sap in the vegetable tissue, to the ascent of fluids in capillary tubes. But it will readily be seen that such hypotheses are insufficient to account for the phenomena in question. If they were owing to the capillarity of the sap-vessels, their action would necessarily be independent of external circumstances, and even of the life of the plant; but this is not the case. Every person knows that the sap no longer circulates in a plant deprived of life. Life has therefore a direct and powerful action upon the exercise of this function. In the suction performed by the roots in the soil, a peculiar vital power has been admitted, on which depend all the phenomena of vegetables, and which forms the distinctive character of living beings, and withdraws them from the influence of physical and chemical agents; this power has also been resorted to for explaining the progress of the sap. In short, if all the phenomena of vegetation were produced by the action of mechanical or chemical agents alone, by what characters could we distinguish vegetables from inorganic objects? We must therefore admit in vegetables, as in animals, a peculiar vital power which influences all their functions. But although this vital power be the agent by which the ascent of the sap is produced, certain internal and external causes may facilitate the exercise of this phenomenon. Among the external causes are to be ranked temperature, and the influence of light and electricity. It is generally known that a high

temperature is singularly favourable to the progress of the sap. In winter, the tree is full of sap, but it is thick and stagnant. In spring, the return of heat causes the ascent of the juices in the vessels of the stem, which seemed to be obstructed by them. Light and the electric fluid have also a decided influence upon the phenomena of the progress of the sap. It is well known that when the atmosphere is long charged with electricity, vegetables acquire a great development, which necessarily implies that the sap moves with more rapidity and power. Certain internal causes, inherent in the vegetable itself, appear also to act upon the ascent of the sap. Of this kind are the greater or less quantity of cortical pores which the vegetable presents, and the greater extent of its surface. These two circumstances are evidently favourable to the rapidity and force of the progress of the sap.

We now proceed to give a summary of the theory of the ascent of the sap, as proposed by Dutrochet, and illustrated by numerous experiments by this ingenious botanist. In the first place, Dutrochet has confirmed prior experiments, that the imbibition of moisture from the soil is accomplished solely by the extreme rootlets or *spongioles* of plants. At the commencement of spring, he performed in the vine successive amputations from the branches downwards to the stem roots, and extreme radicles. At each of these amputations the sap ceased to flow from the upper surface of the separated portion, and proceeded to issue from the part of the plant next the spongioles, till at length he arrived at those spongioles themselves, from which the sap issued in a similar manner. These spongioles are internally composed of a cellular tissue, in which are found minute corpuscles, and covered by an exceedingly thin bark, which in autumn becomes thicker and impervious, and consequently loses its absorbing function. As spring approaches, the spongioles are renewed in the form of buds, from the extremities of those of the previous season. The ascent of the sap at first view, appears to be nothing more than a mechanical action of imbibition carried on by the leaves, as it increases and diminishes in amount with the evaporation from them, and diminishes gradually if they are removed one after the other. But in a more careful inquiry, it will be seen that this mechanical action alone will not account for all the appearances. For in the first place, in the sunshine, or in a diffuse light, the absorption by the roots does not equal the transpiration by the leaves; and if the plant, after losing weight in the light, be removed into darkness, the transpiration then will not equal the absorption. Secondly, although the flaccid state of a plant which has been deprived of moisture, may be rapidly succeeded by the healthy state of turgidity, on an adequate supply of water being restored; nevertheless, this revival will only take place, provided the desiccation has not been carried too far; and the limit of desiccation at which revival will no longer occur, on the one hand, accords with that at which the organized structure of the plant begins to be decomposed, and on the other hand, is much within that at which the plant is to be considered in the light of a sponge, reduced to a state of dryness, and thereby deprived of its power of capillary attraction. Neither can the ascent of the sap, as some have supposed, be owing to air contained in the vessels, which expanding, forces the fluid upwards, for the sap vessels, when cut, exhibit no traces of contained air; nor can it be propelled by a contraction of the vessels, for those in the stems of ligneous plants are of an unyielding and solid nature. In short, Dutrochet concludes that the ascent of the sap is due to a peculiar impulse inherent in the tissue of the plant, and which is dependent on the integrity of its organic structure.—We proceed then to detail Dutrochet's experiments explanatory of his theory.

When a piece of the blind gut or cœcum of a chicken was half filled with milk, and then immersed in rain water, he found that it became gradually fuller and fuller, and at length very turgid, having in thirty-six hours increased in weight, from 196 to 313 grains; when a denser fluid was substituted for the milk, such as albumen or solution of gum, the weight and turgescence, were still more increased, and this increase was more rapidly completed. In eight and a half hours, a cœcum, partially filled, and weighing fifty-eight grains, became extremely turgid, and weighed 130 grains. This transmission of the water by inward impulse he has termed *endosmose*, and corresponds to the imbibition of the moisture of the soil by the roots. It occurs always when the internal fluid is more dense than the external, as also under certain other circumstances to be mentioned afterwards.

On the other hand, when the cœcum was filled with rain water, and immersed in any of the above mentioned fluids, such as milk or albumen, the water passes outwards, through the membrane; and a weaker solution of gum arabic, inclosed in the same way, passed outwards to a stronger solution in which the gut was immersed. This process he termed *exosmose*, or outward impulse; and it corresponds to the imbibition of moisture from the external atmosphere into the interior tubes of plants. But these two processes of endosmose and exosmose, are always reciprocal to a certain degree: thus, while a portion of one fluid passes inwards, a certain portion of the interior fluid also passes outwards. When a little syrup is inclosed in a membranous bag, and immersed in pure water, the water enters the bag; but at the same time, a part of

the syrup passes outwards into the water, and is indicated by its imparting a sweetish taste to the fluid. Or if a solution of common salt be substituted, and submitted to the same process, the escape of the saline solution will be immediately proved by the water becoming white on the addition of a few drops of solution of nitrate of silver. The transmission of fluids, then, is always reciprocal, but that power predominates which transfers the lighter to the denser fluid. Similar experiments were performed with the swimming bladder of the carp, and also with the pods of the bladder senna, and the same results occurred, yet all pervious substances do not possess the same properties. Having observed this state of distension, which was acquired by membranous bags through the influence of endosmose, it immediately occurred to Dutrochet that the reaction of the membrane on its contents might be strong enough to raise to a sensible elevation the fluid diluted by the water which was absorbed. This conjecture was completely verified by a variety of experiments, of which the following is the most striking. The cœcum of a chicken filled with a solution of gum, in five parts of water, was fixed on one end of a glass tube open at both extremities, twenty-four inches long, and a fifth of an inch diameter, and was then immersed in rain water. The fluid gradually rose in the tube at the rate of an inch per hour; and in twenty-four hours flowed over the upper orifice. Here, therefore, is an exact representation of the ascent of the sap, by the impulse communicated to it from the spongioles of the roots. This discovery enabled him to construct an instrument which might serve as a measurer of the power of endosmose. This consists of an inverted funnel and tube, the latter of which is furnished with a scale, while the mouth of the funnel is covered with a piece of bladder, or other organic membrane; and which is supported on a plate of metal, perforated with many holes. The fluid to be tried as a syrup, for instance, is poured into the inverted funnel, the tube is then fitted into the throat of the funnel by means of a cork, and the covered mouth of the funnel is immersed a little under the surface of a glass of rain water, in a tube forty inches long, and a twelfth of an inch in diameter; the fluid will rise at the rate of about six inches per hour and in seven hours will flow over the top.

All fluids having a greater density than water, consequently all the organic animal and vegetable fluids, such as albumen, milk, solution of gum, gelatin, extract syrup, urine emulsions, &c., are exciters of endosmose. Various substances have the same power, by virtue of differences in chemical nature, as nitric, acetic, and muriatic acids, potass, ammonia, and alcohol, the two latter being lighter, and less dense than water. Sulphate and muriate of soda are also powerful exciters, even in very minute quantities. Certain fluids, however, appear quite inactive, although only two such have been well ascertained, and these are sulphuric acid, and sulphuretted hydrogen. Water impregnated with sulphuric acid excites no action, and if even a moderate portion of this acid be added to an active fluid, such as gum, the endosmic action of the latter is destroyed. The same facts are observed very remarkably in the instance of sulphuretted hydrogen. Thus, water containing a twentieth of its weight of gum, excites powerful endosmose, but the solution has no action at all if there be also added to it a 200th part of hydrosulphuret of ammonia. Hence, fœcal matters do not excite endosmose. Hence, too, the various animal fluids formerly mentioned, cease to excite it as soon as they begin to putrify, because they then all evolve sulphuretted hydrogen. Accordingly, when an experiment in which endosmose has been produced, is continued till the fluid putrifies, it rapidly sinks in the tube till the internal and external fluids are on a level.

All organic membranes permit of the processes of endosmose, and exosmose, or as Dutrochet terms it, are active. Of inorganic substances, porous clay, minerals, as a thin layer of gray slate burnt, or a piece of baked clay, are also active. Through a structure of baked clay, one twenty-fifth of an inch thick, endosmose takes place almost as actively as through an organic membrane; and it is perceptible, even through a plate three-fifths of an inch thick. Silicious minerals, on the contrary, have very little activity, and calcareous are quite inactive. All active substances become inactive when they have been penetrated by inactive fluids, as when clogged up by sulphuret of ammonia; but on this matter being washed off, they again resume their activity. Active membranes are rendered after a time inactive by all fluids, except those derived from organic sources; although at first inorganic mixtures may stimulate, and increase this endosmose, yet the velocity soon decreases, and stops altogether at last. The velocity of action differs according to the different densities and temperatures of the fluids, the force or impulses also varying. With a syrup formed of equal parts of sugar and water, the force is calculated as equal to a pressure of four atmospheres and a half. Dutrochet is of opinion that the cause of this ascension of fluids is due to the agency of electricity. The first hint which led him to this conclusion, was taken from some experiments of M. Porret, who found that if a vessel was divided into two compartments, by a partition of bladder, and one was filled with water, while the other contained only a few drops, the water was impelled through the

bladder, when the positive wire of a galvanic trough was immersed into the full compartment, and the negative wire into the other. M. Dutrochet, improving on this experiment, attached an empty cœcum round the end of a glass tube, the aperture of which was stopped up by a cork, and through this cork were passed into the bladder the negative wire of a galvanic pile, and a fine capillary tube, to allow of the escape of the hydrogen gas, formed by the decomposition of the water. The bladder being now immersed in water, into which the positive wire of the pile was plunged, the galvanic circle was no sooner thus completed, than the bag began to swell, and in a few minutes the water rose in the tube, and flowed over its upper orifice. Here endosmose was produced without the aid of a fluid differing either in density or in chemical nature from the transmitted fluid. Reversing the wires, the phenomena of exosmose was produced, and in half an hour the cœcum was emptied.

Dutrochet then points out the numerous resemblances between the common electric actions, and those of endosmose, concluding that in every essential circumstance these phenomena are exactly similar, so that very little doubt can be entertained that the passage of fluids by endosmose and exosmose, depends on electric influences; in short, that on the internal and external surfaces of the membranous bags being brought into opposite states of electricity by the action of fluids, differing in density, or chemical composition, and applied, the one internally, and the other externally, the phenomenon takes place. One very striking point of argument confirmatory of this conclusion seems to be that an elevation of temperature powerfully increases the electric action, as well as the ascent of vegetable juices; the great difficulty hitherto encountered in the theories, explanatory of the circulation of the juices of plants, was to explain by what means the sap both ascended from the roots upwards, and descended by the leaves and bark. This difficulty can, however, be satisfactorily overcome by the ingenious discoveries of Dutrochet. It may be remarked also how appropriately the spongioles of the radicles are constructed to produce endosmose. They have a delicate, thin, and permeable epidermis, covering a series of cellular bodies, which contain a fluid denser than water. Turgidity must therefore take place in them, when water is supplied in sufficient quantity, and as there is no other outlet by which the turgidity can be released, under the elastic reaction of the walls of the spongioles, the absorbed fluid ascends. We have mentioned that endosmose ceases when the permeable membrane, through which it is exercised, loses its regularly organised texture by decay. Accordingly the sap cannot be made to rise at all, if the roots are allowed to dry so far as to undergo decomposition. The action also is comparatively feeble when the temperature is low; hence when the sap is rising in the spring it is found to attain different elevations, according to the degree of heat. The stagnation of the flow of sap in autumn and winter, and of its return in spring, are all referable, also, to the state of the temperature, and to the condition of the spongioles at those periods. For towards the close of autumn, the epidermis of the rootlets becomes coarse and impermeable, and it is not till new spongioles with a tender skin are formed in spring, that absorption can again take place. The leaves also are of such a structure, as to possess the power of exciting endosmose; hence they have a constant tendency to absorb moisture whenever it is presented to them of less density than the juices contained in their cells, and consequently a power of suction must be exerted upon the sap ascending in the lymphatic vessels. This action has been termed the *afflux*, and seems independent of any action of the vessels of the stem, but is due solely to the endosmose of the membrane of the leaves. Thus if a twig of any plant is immersed in water acidulated with sulphuric acid, this fluid will be continued to be drawn up, although every part of the vegetable with which it comes in contact is immediately killed, so that the cellules and tubes may be considered as so many inorganic capillary passages. Endosmose may also be a prime agent in the ordinary transpiration of matter by the leaves. For as has already been stated, wherever endosmose takes place, there is also the reciprocal action of exosmose. The discharge of fluid by the leaves cannot be accounted for by the laws of evaporation alone. For the extent of the discharge is under the influence of agents which cannot affect evaporation, such as diffuse light, and it appears to take place to some extent even under water. Nor is this power generated in the leaves, all expanded in the function of expiration; part of it seems to be spent in effecting the passage of the elaborated sap downwards through the ample tubes; at least, this fluid does not descend from the mere influence of gravity, for when a branch having a ring of bark removed from it is bent downwards, the bark is removed as usual only at the edge of the incision next the leaves, although the elaborated sap must in this position ascend to form it.

Transpiration in the leaves. We have just seen by what force and by what organs the sap is raised from the roots to the extremities of all the branches of the plant. Here other phenomena are produced, and a new circulation commences. When the sap has arrived at the extremities of the branches, it spreads out into their leaves, where it loses part of the principles which it contained, and acquires new ones.

The leaves and green parts are the seat of vegetable transpiration, expiration, and excretion. The sap is deprived, in them, of the atmospheric air which it still contains, of its superabundant quantity of aqueous principles, and of the substances which have become foreign or useless to its nutrition. But while it thus loses part of the principles of which it was previously constituted, it undergoes a particular elaboration, acquires new qualities, and, following a course the reverse of that which it has already performed, descends from the leaves towards the roots, through the liber or vegetating part of the cortical layers.

The transpiration or aqueous emanation of vegetables, is that function by which the sap, on arriving in the leaves, loses and gives out the superabundant quantity of water which it contained.

It is generally in the form of vapour that this water is exhaled into the atmosphere. When the transpiration is not great, the vapour is absorbed by the air as it forms; but if the quantity increases, and the temperature of the atmosphere is low, the liquid is seen transpiring in the form of extremely small drops, which often unite together, and then acquire a considerable size. Thus at sunrise, limpid drops are often observed hanging at the point of the leaves of many grasses. Cabbage-leaves also present them of large size. It was long thought that they were produced by dew; but Muschenbroëk first proved, by conclusive experiments, that they result from vegetable transpiration, condensed by the coldness of the night. He intercepted all communication between a poppy and the ambient air, by covering it with a bell, and between it and the earth, by covering the vessel in which it grew with a leaden plate. Next morning the drops appeared upon it as before.

Hales, in like manner, made experiments to determine the proportion existing between the quantity of fluids absorbed by the roots, and that exhaled by the leaves. He reared a sun flower in a pot of earth, till it grew to the height of three feet and a half; he then covered the mouth of the pot with a plate of lead, which he cemented so as to prevent all evaporation from the earth contained in it. In this plate he fixed two tubes, the one nine inches in length, and of but small diameter; left open to serve as a medium of communication with the external air, the other two inches in length and one in diameter, for the purpose of introducing a supply of water, but kept always shut, except at the time of watering. The holes of the bottom of the pot were also shut, and the pot and plant were weighed for fifteen successive days in the months of July and August. Hence he ascertained, not only the fact of transpiration by the leaves, from a comparison of the supply and waste, but also the quantity of moisture transpired in a given time, by subtracting from the total waste the amount of evaporation from the pot. In a dry and hot day, it transpired the most, and in a damp and wet day, it transpired the least. The mean rate of transpiration being one pound four ounces, that is, seventeen times more in proprotion than that from the human body. In a hot and dry night without dew, it transpired three ounces; in a dewy night it did not transpire at all; and in a rainy night or night of much dew, its weight was increased by three ounces. Hales suspected that the quantity transpired was in proportion to the extent of the surface of the leaves, which he regarded as the principal organs of transpiration, and ascertained also the relative proportion of the capacity of the leaves for transpiration as compared to the capacity of the root for absorption. The surface of the leaves and the stem of the plant which was the subject of experiment was found to be equal to about 5616 square inches, and the surface of the root of the same plant, or rather, of a plant of nearly the same size, was found to be about 2286 square inches; the latter being to the former in the proportion of two to five; from which it follows that the absorbing power of the root is greater than the transpiring power of the leaves, in the proportion of five to two. Similar experiments were also made upon some species of cabbage, whose mean transpiration was found to be one pound three ounces a day, and on some species of evergreens which were found, however, to transpire less than other plants. The same is the case also with succulent plants which transpire but little in proportion to their mass, and which, as they become more firm, transpire less. It is known, however, that they absorb a great deal of moisture, though they give it out thus sparingly, which we cannot but regard as a wise institution in nature, for the purpose of resisting the great droughts to which they are generally exposed, inhabiting as they do for the most part the sandy desert or the sunny rock. Hales also relates corroborative experiments to his own, made by Mr Miller of Chelsea. The result of this was, that, other circumstances being the same, transpiration is in proportion to the extent of transpiring surface, and is affected by the temperature of the air, sunshine, state of moisture, and dryness. It is also greatest from six in the morning till noon, and is least during the night; but when transpiration becomes too abundant, owing to excess of heat or drought, the plant immediately suffers and begins to languish; hence the leaves drop during the day, though they are again revived during the night. For similar reasons, transpiration increases as the summer advances, being more abundant in July than in June, and still more in August than in either of the preceding months, from which last period it begins again

to decrease. But the most remarkable instance of rapid transpiration yet observed, is that which is related by Guettard, who found that a small sprig of the corneil tree transpired, in the course of the day, one ounce and three drachms, a quantity almost double its own weight; they found also in general, that branches deprived of their leaves afford but little transpired matter, and that branches furnished with their leaves afford a great deal; hence it follows that the leaves are the principal organs of transpiration.

The substance thus transpired by the plant may be obtained by enclosing a bough in a glass vessel of proper dimensions luted to the branch. Its properties have not yet been very minutely investigated. Hales and Guettard could discover in it nothing different from common water, except that in some cases it had the odour of the plant. But Duhamel found that it became sooner putrid than water.

These experiments have since been repeated by Desfontaines and Mirbel, who have again found occasion to admire the accuracy and sagacity of the English philosopher. Senebier demonstrated, by numerous experiments, that the quantity of water expired was to that absorbed by the vegetable as two to three. This circumstance is an additional proof that a part of this liquid is fixed or decomposed in the interior of the plant.

These facts incontestably prove: 1. That vegetables transpire by their leaves; in other words, throw out a certain quantity of aqueous fluids. 2. That this transpiration is greater in proportion to the heat and dryness of the atmosphere; whereas in moist weather, and especially at night, there is scarcely any. 3. That this function is performed with greater activity, the younger and more vigorous the plant is. 4. That nutrition takes place more effectually the more the transpiration is proportionate to the absorption; for, when one of these functions is performed with more vigour than the other, the plant languishes. This is observed in plants which, on being exposed to the heat of the sun, fade and lose their vigour, because their transpiration is no longer proportionate to the absorption performed by the roots.

In newly transplanted vegetables the transpiration by the leaves is so great as often to exhaust and destroy the plant before the roots have so far recovered their action as to supply the waste. Hence in all such cases an abundant allowance of water is necessary to secure the health and vigour of transplanted vegetables.

Expiration. We have already shown that vegetables *absorb* or *inspire* a certain quantity of air or of other aëriform fluids, either directly or mixed with sap, by means of their roots and leaves, which operate simultaneously in producing this effect. The portion of these absorbed fluids, which has not been decomposed for the purpose of supplying alimentary matter, is ejected by *expiration.* Plants, like animals, are therefore provided with a kind of respiration, which in the former, as in the latter, consists of two phenomena, inspiration and expiration. This function is very perceptible when we immerse a branch of a tree, or a young plant, in a glass bell filled with water, and expose it to the action of light. There is then seen rising from its surface a great number of small bubbles, which are formed of a very pure air, almost entirely composed of oxygen gas. On the other hand, let the experiment be made in a dark place, and the leaves will expire carbonic acid and nitrogen gass, but no oxygen. It must here be carefully remarked, that all the other parts of the vegetable which are not of a green colour, such as the roots, the bark, the flowers, and the fruits, when subjected to the same experiments, always exhale carbonic acid gas, but never oxygen. Consequently, the expiration of oxygen gas does not depend solely upon the direct influence of the rays of light, but also upon the green colouring of the parts.

We know that vegetables, when exposed to the action of the sun, absorb a great quantity of carbonic acid, which they decompose in the interior of their substance, and eject the greater part of the oxygen which was combined with the carbon. Now, this phenomenon is also a true expiration.

When a plant is dead or languishing, either expiration ceases entirely, or the expired fluid is always nitrogen gas. Some vegetables, even when exposed to the influence of the sun's rays, expire only azote. Of this kind are the sensitive plant, the holly, the rose-laurel, and some others. It seems difficult to point out the true cause of this anomaly.

Excretion. The ejected matters of vegetables are fluids of various degrees of thickness, sometimes capable of condensing and becoming solid. They are of very diversified nature, being sometimes resins, wax, or volatile oils; sometimes saccharine substances, manna, fixed oils, &c. All these substances are thrown out at the surface by the power of vegetation. Thus the *fraxinus ornus*, and some other species of ash, in Calabria, exude a thick saccharine fluid, which, under the action of the air, becomes concrete, and forms *manna*, pines, firs, and, in general, all trees of the family of coniferæ, furnish large quantities of resinous matter. Many plants, such as the *Ceroxylon andicola*, a superb species of palm, described by Humboldt and Bonpland, and the *Myrica cerifera* of North America, yield a large quantity of wax, which is usefully employed in the countries to which these plants are indigenous.

What is generally called *perceptible* perspira-

tion is an exudation of sap, too gross or too abundant to be dissipated immediately, and which hence acumulates on the surface of the leaf. It is very generally to be met with in the course of the summer on the leaves of the maple, poplar, and lime tree; but particularly on the surface exposed to the sun, which it sometimes wholly covers. Its physical as well as chemical qualities are very different in different species of plants, so that it is not always merely an exudation of sap, but of sap in a high state of elaboration, or mingled with the peculiar juices or secretions of the plant. Sometimes it is a clear and watery fluid, conglomerating into large drops such as are said to have been observed by Miller of Chelsea exuding from the leaves of the plantain, and such as are to be seen in hot and calm weather exuding from the leaves of the poplar, or willow, and trickling down in such abundance as to resemble a slight shower. This was observed by Smith under a grove of willows in Italy, and is said to occur sometimes even in England. Sometimes it is glutinous, as in the leaf of the lime tree; sometimes waxy, as in the leaves of the rosemary; saccharine, as on the orange leaf. On the leaves of the *cistus creticus* is exuded a resin known by the name of *labdanum*. The exudation from the Lombardy poplar has been rendered famous by Ovid, who fables them as the tears of Phaeton's sisters, who were transformed into this species of poplar. The leaves of fraxinella are also said to be often covered with a sort of resinous substance; and after a hot day, if the air is calm, the plant is even found to be surrounded by a resinous atmosphere, which may be set on fire by the application of the flame of a candle. This is said to have been the discovery of a daughter of the celebrated Linnæus. Sometimes this exudation is a redundancy so great as to constitute a disease of plants; of this nature is the honey dew, a sweetish substance exuded by the hop plant, beech tree, &c.

Roots, as before remarked, also excrete, by their slender extremities, certain fluids, which are injurious or useful to the plants that grow in their vicinity; and in this manner, the likings and antipathies of certain plants may be accounted for. Thus, it is well known that the creeping thistle is hurtful to oats, *erigeron acris* to wheat, *scabiosa arvensis* to flax, &c. Such are the different phenomena which depend upon the presence of the sap, when it has arrived at the upper parts of plants. Let us now follow it in its retrograde course from the leaves to the roots.

The descending Sap. This has been a subject of much discussion among physiologists, several of them having long denied the existence of a descending sap; but the perceptible phenomena of vegetation, and the most accurate experiments, have demonstrated that there really is a second sap, which follows a course the reverse of that which we have just examined. If a strong ligature be applied to the trunk of a dicotyledonous tree, there forms above it a circular swelling, which gradually becomes more prominent. This swelling could not be formed by the sap which ascends from the roots toward the leaves. Were this the case, it ought to present itself beneath the ligature, and not above it; but this is not what happens. The swelling, therefore, can only depend upon the obstacle which the juices encounter as they descend from the upper parts of the plant to the lower, in their passage through the cortical layers. There is, therefore, a descending sap.

The descending sap, divested of the greater part of its watery principles, more highly elaborated, and containing more nutritious principles than the ascending sap, contributes essentially to the nourishment of the plant. As it circulates in the vegetating part of the stem, the only part susceptible of growth, its uses cannot be equivocal.

Let us examine more strictly the phenomena which result from the application of a circular, ligature to the trunk of a dicotyledonous tree, and we shall see that not only does a swelling form above the ligature, but also that the part of the trunk situated beneath it ceases to grow, no new circular layer being henceforth added to those which previously existed. Hence we see, in the clearest manner, the use of the descending sap. It continually maintains and renews the cambium, and contributes essentially to the growth and development of dicotyledonous trees.

But this second sap is not of the same nature in all vegetables. There are some in which it forms a white and milky juice, as in the *euphorbiæ*. In others, as poppies, it is a yellowish or brownish fluid; and in the firs it is resinous. But it is necessary to remark, that, in the opinion of many physiologists, the proper juices of plants are not the descending sap itself, but fluids which are separated from it by the act of vegetation. The diversity of nature which these juices present, their occurring in some vegetables only, and their being contained in vessels appropriated to themselves and existing in small number, appear so many proofs in favour of this opinion.

We have now given a successive account of the various phenomena which are connected with the nutrition of plants, or contribute to effect it. We have seen the juices which have been absorbed by the roots in the earth conveyed by an inherent power, depending upon the life of the plant, and electric influence, to the highest parts of the ultimate ramifications of the stem. There, we have seen them mingling with the

absorbed fluids, losing such of their aqueous and aëriform principles as are useless for nutrition, and thus acquiring new properties; after which, pursuing a retrograde course they become the true aliment of the plant.

We thus see, that, although nutrition in plants has a great similarity to the same function in animals, it yet differs essentially from the latter. Thus animals introduce by their mouth the different substances by which they are nourished; while plants absorb, in the interior of the earth, by the imbibing orifices which terminate their roots, water impregnated with substances which are either necessary or useful for their nutrition.

In animals, the substances that have been introduced pass along a single canal, from the mouth to the place where the substance which is alone directly subservient to nutrition (the *chyle*,) is to be separated from the useless parts. In vegetables the same phenomena take place; the absorbed fluids pass through a certain course before they arrive at the leaves, in which the parts essential to nutrition are separated from those which are useless. Both animals and vegetables eject the substances which are unfit for their nutrition.

One of the most striking differences between vegetables and animals consists in the circumstance, that the former are essentially nourished by inorganic substances, such as water, carbon, hydrogen, &c., whereas the substances which are subservient to the nutrition of animals are organic, and derived from the animal and vegetable kingdoms.

The chyle, by which the nutrition of animals is effected, mingles with the blood, which it continually renews and keeps up in due quantity, circulates through all parts of the body, and serves for the development and nutrition of the organs. The sap of plants, after being exposed in the leaves to the influence of the air, which changes its nature and properties, descends into all parts of the vegetable, carrying into them the materials necessary for their growth, and thus effecting the development of all their parts.

CHAP. XII.

THE ORGANS OF REPRODUCTION, AND HISTORY OF THEIR DISCOVERY.

The Organs of reproduction, which are also called Organs of Fructification, are those by which the preservation of species and the propagation of races are effected. Their office is not less important than that of the organs whose structure and uses we have already examined; for, if the latter are necessary for the existence of the individual, and the development of all its parts, the organs of reproduction are equally necessary to enable the individual to procreate others similar to itself, by which its species may be renewed and perpetuated.

In plants, the flower, the fruit, and the various parts of which they are composed, constitute the organs of reproduction.

Here we find a great resemblance between animals and vegetables. Both are provided with particular organs, which by their mutual influence concur in producing the most important function of their life. Generation is the ultimate object for which nature has created the various organs of vegetables and animals. They exhibit the most perfect similarity in respect to this great function. From the action which the male organ exercises upon the female organ, fecundation takes place, by which the embryo, yet in the rudimentary state, receives and preserves the vivifying principle of life. Here, however, we remark the modifications which nature has impressed upon these two great classes of organized beings. Most animals are furnished at birth with the organs which are, at a future period, to effect their reproduction. These organs remain in a state of torpidity until the period when nature, imparting to them a new energy, renders them capable of performing the offices for which they were destined. Vegetables, on the contrary, are, at their first appearance, destitute of sexual organs, these not being developed by nature until the moment when they are to be employed for the purpose of fecundation. Another great dissimilarity between animals and vegetables is, that, in the former, the sexual organs are capable of performing the same function several times, and exist during the whole life of the individual which bears them; while in vegetables, which have a soft and delicate texture, these organs have only a temporary existence, make their appearance for the purpose of accomplishing the views of nature, and fade and disappear whenever they have performed their office.

We admire the wisdom by which Nature has regulated the distribution of sexes in organized beings. Vegetables, which are invariably fixed to the place in which they have sprung to life and are destitute of the locomotive faculty, usually bear on the same individual the two organs by the mutual action of which fecundation is to be effected. Animals, on the other hand, which, being possessed of will and the faculty of moving, can pass in any direction from one place to another, generally have the sexes separated upon distinct individuals. For this reason, the union of the sexes in one individual is as common in vegetables as it is rare among animals.

The flower is essentially constituted by the

presence of one of the two sexual organs, or of the two placed together upon a common support, with or without external envelopes intended for their protection. In its greatest degree of simplicity, the flower may, therefore, consist of only a single sexual organ, male or female, that is, of a *stamen* or a *pistil*. Thus, in the willows, whose flowers are *unisexual*, the *male* flowers merely consist of one, two, or three stamina, attached to a small scale. The *female* flowers are formed of a pistil, which is also accompanied with a scale, but without any other organs. In this case, as in many others, the flower is as *simple* as possible. It then takes the name of *male flower*, or *female flower*, according to the organs of which it is composed. The *hermaphrodite flower*, on the other hand, is that in which the two sexual organs, the male organ and the female organ, exist together.

But the different flowers which we have just examined are not *complete;* for although the essence of the flower consists in the sexual organs, yet, before it can be called perfect, it must present other organs, not indeed essential to it, but which, nevertheless, belong to it, and assist it in performing its functions. These organs are the calyx and corolla, which give support and protection to the parts of fructification. The fact of the existence of two kinds of flowers in plants was at an early period so far conjectured by botanists; but its complete elucidation has only been made at a very modern date. As this is a most curious and important discovery in the history of the vegetable kingdom, we shall, before going into a description of the sexual organs, trace the progress of opinion on the subject from the earliest periods to the present time.

It cannot, says Dr Keith, now be ascertained with whom, or at what particular period, the notice of vegetable sexuality originated; but its antiquity is unquestionably great, as it appears to have been entertained even among the original Greeks, from the antiquity of their mode of cultivating figs, and to have been made the subject of the speculations of some of their earliest philosophers. Empedocles taught that the sexes were united in plants, a doctrine involved indeed in that of Anaxagoras, by which the desires and passions of animals are attributed to vegetables. It was evidently a prevalent notion throughout Greece, and the nations to the east of Greece, in the time of Herodotus, who recognises it in his account of the cultivation of the Babylonian palm, which he represents as being cultivated in the country around Babylon in the manner of figs; the cultivator taking the flower of that palm which the Greeks call the male palm, and binding it around the flowers of the fruit-bearing palm, that the fruit may not fall immature. Whether the beneficial effect resulting from this practice, was produced by the agency of insects generated in the male plant, as Herodotus asserts, it is not our object at present to inquire. It is enough to have ascertained that the notion of a sexual distinction in plants existed, or rather was a general and prevalent idea, in the age of Herodotus, that is, about 400 years before the Christian æra. The next authority is that of Aristotle, who maintains the doctrine of a distinction of sex in plants as well as in animals, though he admits that some plants are altogether without sex; and represents the beneficial effect of the practice adopted in the cultivation of the palm, as resulting from the action of the dust of the male flower quickening the maturity of the fruit, which it is said to effect equally well, if it is wafted to the female flower by means of the wind. Theophrastus, the disciple and successor of Aristotle, who pursued his botanical investigations to a much greater length than his master, maintains also the doctrine of the sexuality of vegetables, which he illustrates with more of detail; and exemplifies not only in the case of the palm tree, but in that also of the fig, and a variety of others. The barren palm he calls the male, and the fruit-bearing palm the female, pointing out at the same time the ground of this distinction, as consisting in the indispensable necessity of the co-operation of the flower of the barren palm, to the ripening of the fruit of the fertile palm, the fruit of the fertile palm being otherwise extremely apt to fall off before it becomes ripe. But if the spathe of the male plant containing the male flowers, is cut off and shaken over the flowers of the female plant, the fruit does not fall, but is preserved till it is matured; in which case, he adds, there is a sort of junction of the male and female. But beyond the example of the date-palm, and such other plants as produce barren or fertile flowers on distinct individuals, Theophrastus does not seem to have entertained any correct notions of vegetable sexuality. For although he institutes the distinction of sex in other families also, yet it is by no means on the same principle, but rather upon that of the habit or aspect of the plant, or upon the quality of the timber when felled; the male being represented as shorter and stouter, and the female as taller and more slender, as erroneously exemplified in the case of the larch, which is well known to produce no individuals that are exclusively male or female; as well as in the case of the lime tree, of which it is also added, that the male plant is not only barren, but destitute even of flowers. And to complete the mystery in which the doctrine was yet involved, the male plant is in some cases said to have fruit as well as the female. From all which it follows, that the doctrine of vegetable sexuality was but very imperfectly understood in the time of Theophrastus.

After a long blank in the annals of botanical research, the next traces of inquiry relative to the sexuality of vegetables, are such as occur in the works of Pliny, Dioscorides, and Galen, who also adopted the division by which plants were then distributed into male and female, but chiefly upon the erroneous principle of habit or aspect, and without any reference to a distinction absolutely sexual; the fertile plant being sometimes denominated the male, and the barren plant the female, as in the example of male and female mercury, in which the true notion of vegetable sexuality was altogether reversed. Pliny seems, however, to admit the distinction of sex in all plants whatsoever, and quotes the case of the palm tree as exhibiting the most striking example. Cesalpinus, who follows next in order, though not till after an interval of many centuries, enters more into the detail of the doctrine, and speaks with more confidence on the subject than any preceding botanist. Trees which produce fruit only, he denominates females, and trees of the same kind which are barren, he calls males, adding that the fruit is found to be more abundant, and of a better quality, when its males grow in the neighbourhood of the females, which is, as he says, occasioned by certain exhalations from the males dispersing themselves all over the females, and by an operation not to be explained, disposing them to produce more perfect seed. Still, it seems doubtful whether any conjecture had been yet formed with regard to the peculiar and appropriate organs by which the sexual intercourse is conducted.

Zeluzianski, a native of Poland, who lived about the end of the sixteenth century, is said to have made some considerable discoveries regarding the sexuality of vegetables. But as his book, if he ever published one, is not now to be met with, no one seems able to say what his discoveries were, if rather, they are not a transcript of the discoveries of Cesalpinus. At last, however, about the middle of the seventeenth century, when the improved philosophy of Bacon had begun to be adopted even in Botany, and its cultivation to be directed by observation and experiment, rather than by conjecture; the doctrine of the sexes of plants began also to assume a more fixed and determinate character, and to exhibit the legitimate evidence of being founded on fact. Still, it is difficult to say who first discovered and pointed out the peculiar organs by which the sexes are respectively characterised; not that these organs had been overlooked in the description of the flower, but that their functions had been misunderstood. Malpighi, who describes not only the stamens and anthers, but also the pollen contained in them, regards the former as excretory organs contributing to the perfection of the seed, and the latter as the substance excreted. The true use of the pollen, therefore, was not yet discovered. The merit of suggesting its true use seems to be between Sir T. Millington, professor at Oxford, and the celebrated Dr Grew, who represents the suggestion as originating with the professor, and consisting in the expression of an opinion that the stamens serve as the male organs of the vegetable for the purpose of the generation of the seed, which opinion he seems himself to have previously entertained, or at the least, to have acquiesced in as soon as it was suggested. This we may regard as the first glimpse that was ever caught of the true and proper use of the stamens; and the discovery may be dated about the year 1676. But the opinion, if not first suggested, was at least first published by Dr Grew, in his Anatomy of Plants, together with the grounds on which he had adopted it, and the illustrations which its novelty demanded, or his researches had furnished; so that he does not merely ascribe a peculiar function to the stamens, but points out also the mode in which he thinks that function is discharged, and which is represented to be as follows. When the summits of the stamens or anthers surmounting the filaments burst open in the process of vegetation, the inclosed pollen falls upon the pistil and impregnates the embryo, not by actually entering the pistil, but by means of a subtile and vivic effluvium; hence the stamens are the male, and the pistils the female organs of vegetable impregnation. This was the very discovery that furnished the clue for the unravelling of the whole of the mystery overhanging the subject, because it is equally applicable to all sorts of vegetables whatever; whether producing the organs in question in separate flowers, and on separate plants, as in the case of the palm tree; or in separate flowers, and on the same plant, as on the hazel; or lastly, in the same flower, as in the lily, which last is by far the most general mode of vegetable sexuality. The opinion of Grew was adopted also by Ray at first with some appearances of doubt, but finally without any sort of reservation, as being founded on evidence which appeared to him sufficiently convincing, and which he was even induced to illustrate. Hitherto the doctrine of the sexuality of vegetables had been supported chiefly upon the ground of its probability, as arising from careful observation, or upon that of the necessity of the case, and had not yet been confirmed by the evidence of actual experiment; but this confirmation, which was so devoutly to be wished, and without which all other arguments must have remained insufficient, was at length also happily undertaken. The first example of experiment recorded on this subject is that of Camerarius, who, having adopted the opinions of Grew and Ray, though, perhaps, without regarding their arguments as the best that could be adduced, conceived that

the subject might be still farther illustrated by means of depriving the plant of its male flowers altogether, or of removing the individuals of different sexes to a distance from one another. Accordingly, having selected some plants, and stripped them of their stamens or male organs, or separated the male flowers entirely from the female, he found that the fruit did not now ripen; the inference from which was, that the generation of plants is analogous to that of animals, and that the stamens of the flowers of the former correspond to the sexual organs of the males of the latter.

But though the fact of the sexuality of vegetables seemed thus unequivocally ascertained, the peculiar mode of their fecundation was still left undetermined. Some conjectures had been offered with respect to it by Cesalpinus and Grew, the former regarding it as being effected by means of an exhalation from the male flower, and the latter by means of an effluvium from the pollen; but Moreland, who published a paper on the subject, in the Philosophical Transactions for 1703, in which, indeed, he adopts the opinions of Grew with regard to the functions of the stamens, contends however, that the pollen is a congeries of seminal plants, one of which, at least must be conveyed through the style into the ovary, before it can become prolific. This conjecture seems to have arisen out of the theory of Leuwenhoeck on animal generation, which was then popular; but it is not corroborated by any experiments. It seems, however, to have had the effect of keeping alive the discussion of the subjects. For Geoffroy, in his memoir presented to the Royal Academy of Sciences in 1711, on the structure and use of the principal parts of the flowers, endeavours, as it appears, to reconcile the discordant theories of Grew and Moreland, and maintains that the germ is never visible in the seed till the anthers have shed their pollen, adding, that if the stamens are cut off before the anthers burst, the seeds remain barren. In this we have a step in advance beyond the point that had been gained by means of the experiments of Camerarius, which relate only to monœcious and diœcious plants, in which the proof is less difficult than in hermaphrodites, to which Geoffroy's experiments apply. From the spirit of inquiry which was thus excited, new discoveries could not but be expected to follow; for although the doctrine was discountenanced and rejected by some of the leading botanists of the time, and even by the illustrious Tournefort, yet it was too well established in fact to be overthrown by any argument, or any authority. Accordingly, its evidence was becoming every day more irresistible, and its advocates more confident. Vaillant in a dissertation on the structure of flowers, read at the opening of the Royal Garden at Paris in 1717, supports the doctrine of the sexes of vegetables by new accessions of experiments, and throws additional light both on the structure of the pollen and manner of its expulsion, which he represents, however, in terms too glowing for the style of sober narrative, but by which he appears, according to the remarks of a contemporary author, to have been the first eye witness of that secret operation of nature, "the loves of the plants."

But the doctrine of the sexes of vegetables which was thus daily acquiring new accessions of proof, was destined to receive its last degree of elucidation from the pen of Linnæus. This great and illustrious botanist, reviewing with his usual sagacity the evidence on which the doctrine rested; and perceiving that it was supported by a multiplicity of the most incontrovertible facts, resolved to devote his labours peculiarly to the investigation of the subject, and to prosecute his inquiries throughout the whole extent of the vegetable kingdom; which great and arduous enterprise he not only undertook, but accomplished with a success equal to the unexampled industry with which he pursued it. So that, by collecting into one body all the evidence of former discovery or experiment, and by adding much that was original of his own, he found himself at length authorised to draw the important conclusion,—that no seed is perfected without the previous agency of the pollen, and the doctrine of the sexes of plants is consequently founded on fact. It may not be deemed uninteresting here, to give a brief summary of the facts and deductions which led to this important conclusion.

In all plants hitherto discovered, it has been observed that the fruit is uniformly preceded by the blossom, and that without blossom there is no fruit. This is a remark that can scarcely fail to be made even by the most inattentive observer, at least with regard to such plants as come within the sphere of his notice, as every school boy knows, that unless the cherry tree blossoms in spring, he will gather no fruit from it in summer. This proves that the organs necessary to the production of the fruit exist in the flower, and is one step at least towards the general conclusion. But to this rule there exists a seeming exception, in the case of the meadow saffron, which produces its fruit in the spring, and its flower in the autumn, so that the former has the appearance of being the cause of the latter. But the truth is, that the fruit which ripens in the spring is the natural result of the flower of the preceding autumn; for if the flower is cut off in autumn before its expansion, no fruit will be produced in the succeeding spring, and yet, if the fruit is cut off at any time during spring, the blossom, nevertheless, succeeds in autumn. There exists also another seeming exception in the case of the pine apple, in which

the part that is commonly called the fruit is formed before the flower expands. But when it is recollected that this alleged fruit is merely a fleshy receptacle, and that the seed, the only essential part of the fruit, is not developed till after the expansion of the flower, the seeming exception vanishes. The fruit-bearing individuals of such species as have their barren and fertile flowers on distinct plants, do not perfect their fruit, except where individuals of both sorts are sustained in the vicinity of one another. This observation is confirmed not only by the testimony of the ancients, and their manner of cultivating the palm and fig tree, but also by the additional observations of the moderns. Father Labat, a French ecclesiastic, who had undertaken a voyage to the West Indian islands, about the year 1745, says, that when he was in the island of Martinique, there was then growing near the monastery of the order to which he belonged, a female date tree which bore fruit though single, there being no other tree of the same species within two leagues of it; but he adds, that the stones of the dates it produced did not germinate. It is plain therefore, that the fruit was not perfect, though it might have been apparently complete. A female plant of the *cycas revoluta*, in the possession of the bishop of Winchester, produced also fruit though single; but the drupi, which was externally and apparently complete, was found, when dissected by Sir J. Smith, to be internally very defective; for, in place of the embryo, the most important part of the whole, all that could be discovered was only a minute cavity, which defect Sir J. Smith rightly attributes to the want of the vicinity of a plant furnished with male flowers, which, he adds, was perhaps not to be found nearer than Japan. The fruit then is perfected by means of some substances conveyed from the barren to the fertile flower, and capable, as it appears, of being transmitted through the medium of the atmosphere, if the respective plants are situated in the vicinity of each other. But in the case of the fig tree, vicinity is not even enough, the structure of the fruit being such as to require a peculiar mode of transmission; for the fruit of the fig is not, as in most other cases, a pericarp enveloping the seed, but a common calyx or receptacle, enclosing the flowers; this may be readily seen by means of cutting a fig in two, in the direction of the longitudinal axis of the fruit, in the centre of which there will be found a cavity lined with a multitude of flowers, the male and female blossoms being generally in different figs, and in distinct plants; the medium of communication between them being only a small aperture at the summit of the receptacle. Hence, the access of the substance necessary to impregnation, is rendered impracticable in the ordinary mode of transmission. But nature is not without a resource, even in this difficulty. For in Greece and Italy, and the islands belonging to them, the native country of figs, a species of insect of the genus Cynips, which is continually fluttering about from fig to fig, for the purpose of depositing its eggs in the cavity, carries the substance necessary to impregnation from the male to the female flower. But the substance which it carries is the pollen of the anthers, with which it becomes covered all over in rummaging through a variety of receptacles, till it finds one to please it. The pollen then is the substance by which the impregnation of the female flower is effected, and the whole of the phenomena of the growth, and economy of flowering, tends to corroborate the fact. In Italy and the Levant, where the fig is much cultivated, the cultivator insures or facilitates the agency of the insect, by presenting it to the fig at the time proper for impregnation, and the service he thus performs is called caprification. If the stamens or pistils of flowers, are destroyed by cultivation, or injured by rain or frost, or by the operation of any other natural cause, the process of impregnation is interrupted or prevented, and the fruit deteriorated or diminished in quantity or quality. Sometimes they are wholly obliterated by means of cultivation, as in the case of double flowers, in which the stamens degenerate into petals, and the pistil not unfrequently into a leaf; but in this case it is well known that no flower produces perfect seed. Sometimes they are injured by accidents arising from weather, and even in such vegetables as are the most serviceable for the food of man, particularly in crops of grain; but some sorts of grains are much more liable to be injured by such accidents than others. Crops of rye, for instance, are much more liable to be injured by heavy and continued rains than crops of barley, because the anthers are better sheltered by the husks of the latter than the former. But shrubs and trees are affected in the same manner as the plants now mentioned. It was observed by Linnæus, that the juniper produces few or no berries in Sweden if the flowering season is wet, and that the cherry tree is much more liable to come short of its annual crop than the pear tree, because in the latter the blossoms are unfolded, and the stamens and pistils matured all about the same time, so that the whole of them might be blasted by the dews or frosts of a single night. Whereas, in the former the blossoms are unfolded, and the stamens and pistils matured by gradual and successive steps, so that if part of them should happen to be destroyed by the occurrence of a frosty morning, the rest may escape. But the fruit is equally blasted whether the injury is done to the stamens or to the pistils, the stamens being the organs in which the impregnating substance is contained, and the pistil being the channel through which it is conveyed

to the ovary. Hence, we may account for the peculiar care with which these organs have been guarded by the hand of nature from external injury; sometimes this is effected by means of a nodding or pendant flower, as in the case of the crown imperial, and the cowslip, in which the intention of nature is the more evident in that the flower stalk after the time of flowering becomes gradually erect, even though loaded with fruit; sometimes it is effected by means of a capacity inherent in the petals, of folding themselves together in the night, and opening themselves out again in the morning, as in the case of many of the *Papilionaceous* and compound flowers, particularly the pea and dandelion. But one of the best examples of this capacity is that of the white water lily, which closing its petals as the sun begins to get low, and shrinking into itself, reposes its lovely blossom upon the surface of the water till the morning, when it again raises its head, sometimes to the height of several inches, and presents its expanded petals to the noon-day sun. A phenomenon still more singular is related by Theophrastus, as occurring in what he calls the lotus, perhaps the *nymphea lotus* of Linnæus, of which he says, though only on report, that in the Euphrates the flower keeps sinking till midnight, when it again begins to ascend, but more rapidly as day advances, elevating itself to the surface about sunrise, and afterwards expanding and rearing its head high above the water. Some flowers are so very susceptible to changes of atmosphere, as to shut up their petals even upon the approach of rain. One of the most remarkable examples of this sort is that of the *anagallis arvensis*, or poor man's weather glass, which appellation it seems to have obtained from its peculiar susceptibility, always shutting up its blossoms even upon the slightest symptoms of approaching rain, except in the case of a sudden thunder storm, when it happens to be taken by surprise. But Sir J. E. Smith says he has reason to think that its susceptibility is apt to be impaired, and sometimes totally destroyed, by long continued wet; and Linnæus remarks, that flowers in general lose this susceptibility when the anthers have discharged their pollen. The pollen is generally discharged from the anther in such a manner as to ensure its dispersion, at least to any pistil that is near it, and at such a time as pistils of the same species are best fitted to receive it. When the anther has given indications of maturity by the distended appearance of its cells, the valves of which the cells consist become daily more and more indurated, till at last they fly open with a sudden jerk, and discharge the contained pollen as if by the force of an elastic spring. The cypress tree affords a good example of this, when the pollen is thrown out with such force, and in such abundance, as to resemble a little cloud of smoke; but the same circumstances may be observed in the discharge of the pollen from the male catkins of the birch and willow, particularly if they are suddenly shaken, or agitated by the wind, in which case a portion of the pollen can scarcely fail to alight upon the pistil-bearing and contiguous flowers, or to be wafted to them if even at some distance. But at the season of the discharge of the mature pollen, the pistil is also peculiarly adapted to receive it, as is evident from the state of the stigma. Sometimes this adaptation consists in the stigmas then assuming a peculiar form or shape, as is exemplified in the pansy and the *gratiola marlynia*, both of which are furnished with what botanists call a gaping stigma, opening as if to receive the pollen, yet not in the early stage of its growth, nor during its decline, but in the intermediate stage only when the pollen is ripe. But the adaptation generally consists in the stigmas being then moistened with an exuding and viscous fluid, except in the case of a hispid stigma, in which no such exudation is discoverable, as is peculiarly well exemplified in the case of the *amaryllis formosissima.* This beautiful flower, which when fully expanded is pendulous, exhibits the curious phenomenon of the exuding of a fine and limpid fluid from the surface of the stigma every morning, which augments as the day advances, and forms about noon a drop so large that one would think it in danger of falling to the ground. It is re-absorbed, however, by the style about three or four o'clock in the afternoon, and again protruded about ten o'clock on the following morning. This limpid drop, which is thus regularly exuded and absorbed, is intended, no doubt, in the economy of the flower, to facilitate the process of impregnation, by catching a portion of the pollen as it is discharged from the anther, and conducting it to the ovary. It is at least certain that the pollen reaches it, and is detained by it, as a number of drenched and disfigured particles may generally be seen adhering to the surface of the stigma after the drop has been absorbed. Perhaps it may even have some effect in forwarding the explosion of the pollen, which is known to be also strongly affected by moisture. As the stamens and pistils grow and come to maturity together, so they also decay together; the stamens shrinking and withering immediately after the anthers have discharged their pollen, and the stigma withering also and falling off much about the same time, even when the style remains an appendage to the fruit.

The relative proportion, situation, and mutual sympathies of the stamens and pistils, are such as seem expressly calculated to facilitate the process of impregnation. In pendulous flowers the pistil is generally longest, as in the case of the lily; but in upright flowers the stamens are

generally the longest, as in the ranunculus. In simple and hermaphrodite flowers, the situation of the pistil is invariably central with regard to that of the stamens, as may be seen by examining any kind of flower. In plants of the class *Monœcia* the barren blossoms stand generally above the fertile blossoms, even when situated on the same footstalk, as may be seen in the case of the *carex* and *arum*. And in plants that have their barren and fertile flowers on distinct individuals, the blossom is generally protruded before the leaves expand. But a very little reflection will serve to show that all the above arrangements are institutions of nature, by which the pollen, when it explodes from its envelopes, shall possess the best possible chance of coming into contact with the pistil or stigma. And when such means are wanting, nature displays a variety of other contrivances to effect the same end. The style of the *gloriosa superba* is bent towards the stamens at a right angle, even from the very base, and for no other conceivable purpose but that of throwing itself in the way of the pollen when discharged. The stamens of the saxifrages bend down to the pistil one or two at a time; if two, those then are opposite each other, and discharge their pollen directly over the stigma, returning afterwards to their former position, and giving place to one or two others successively, which also retire in their turns till all of them have discharged their pollen. Similar effects have been observed in the flowers of the garden rue and others. But the most singular example of this kind is that which is exhibited in the stamens of the flower of the berberry bush; the stamens, which are six in number, lie sheltered under the concave lips of the petals, as long as they are allowed to remain undisturbed; but if any extraneous body, whether by accident or design, is made to touch a stamen at the base of the filament, it immediately collapses with a sudden jerk, and bends inward till the anther strikes against the summit of the pistil, discharging its pollen if ripe, and again retiring. This curious and singular fact seems to have been first discovered by Sir J. E. Smith. The experiment may easily be tried by applying the point of any instrument, sufficiently delicate, to the inner side of the base of the stamen, when it will immediately spring forward till it strikes against the pistil; and it is to be presumed, that the same effect is produced in the natural order of things, by means of the feet or trunks of insects rummaging the flower in quest of honey. The economy of many of the aquatic plants, seems also expressly intended to facilitate the process of impregnation. Many plants of this class that vegetate, for the most part, wholly immersed in water, and often at a considerable depth, gradually begin to elevate their stems, as the season of flowering advances, when they at last rear their heads above the surface of the water, and present their opening blossoms to the sun till the petals have begun to fade, when they again gradually sink down to the bottom to ripen and to scatter their seeds. This very peculiar economy is seen in the case of *puppia maritima*, and several species of *rotamogeton*, which are common in our ponds and ditches; from which we may fairly infer, that the flowers rise thus to the surface merely to give the pollen an opportunity of reaching the stigma uninjured. But the most remarkable example of this kind is that of the *valisneria spiralis*, a plant that

87.

grows in the ditches of Italy. The plant belong to the class *Diœcia* producing its fertile flowers on the extremity of a long and slender stalk, twisted spirally like a cork screw, which uncoiling of its own accord about the time of the opening of the blossom, elevates the flowers to the surface of the water, and leaves them to expand in the open air. The barren flowers are produced in great numbers upon short upright stalks issuing from a different root, from which they detach themselves about the time of the expansion of the female blossoms, mounting up like little air bubbles, and suddenly expanding when they reach the surface, where they float about in great numbers among the female blossoms, and often cling to them in clusters so as to cover them entirely; thus bringing the stamens and pistils into immediate contact, and giving the anthers an opportunity of discharging their pollen immediately over the stigma. When this operation has been performed, the now uncoiled stalk of the female plant begins again to resume its original spiral form, and gradually sinks down as it gradually rose, to ripen its fruit at the bottom of the water.

Such are the proofs of the sexuality of vegetables, arising from the observation of the natural phenomena exhibited in the economy of flowers; we shall now enumerate those proofs deduced from experiment. If the anthers of an

hermaphrodite flower, or the stamen bearing flowers of a monœcious plant are cut off before they shed their pollen, and care taken to prevent the access of the pollen of any other plant of the same species, the fruit will prove abortive. From a flower of the red horned poppy (*chelidonum corniculatum*) which was detached from all other individuals of the same species, Linnæus removed all the anthers upon the first opening of the blossom, and stripped off at the same time all the rest of the flowers; but the result of this experiment was that the flower produced no seed. A gardener who cultivated melons and cucumbers, but who was no botanist, thinking that the stameniferous flowers of the plant exhausted the nourishment due to the other flowers, without being of any utility in themselves, fancied that his plants would be rendered more vigorous, his fruit of superior flavour, and his profits consequently increased, by means of tearing them off altogether. But like the boy who cut open his goose that laid golden eggs, in the hope of getting rich all at once, he soon found cause to repent of his rash experiment, for the consequence was that his plants produced no fruit. If, after the anthers have been removed, the pollen of another plant of the same species be shaken over the pistil, then the fruit will ripen as usual. Linnæus proved this by first treating a flower of the *chelidonum corniculatum*, as in the foregoing experiment, and then sprinkling over the pistil pollen brought from another plant of the same species; when the flower produced perfect seeds. Upon this principle, gardeners now assist the impregnation, or what they call the setting of the fruit, at least in the case of their melons and cucumbers, by means of sprinkling the pollen of the male flowers over the pistils of the females. But if a plant has more than one pistil, and you apply the pollen only to that one, then that one only will ripen seed.

If the stigma of the pistil is cut off before the discharge of the pollen, no fecundation ensues, and the fruit is inferior both in quantity and quality. If, again, the stigma of a flower that has been stripped of its stamens before the bursting of the anthers is sprinkled with the pollen of a plant of a different species, then the seeds will not only ripen and produce perfect plants when sown, but these plants will partake of the qualities both of the fecundating and fecundated species. The pollen of the *tragopogon pratensis*, whose petals are yellow, when sprinkled on the stigmas of the flower of the *tragopogon purpureus*, whose petals are purple, yielded seeds that produced plants with both purple and yellow flowers. Hence botanists account for the existence of what are called spurious plants, attributing them to the accidental mixture or access of the pollen of a different species. Thus, *veronica spuria* is thought to have sprung from *veronica maritima*, impregnated by the pollen of *verbena officinalis*, agreeing in its fructification with the former, and in its leaves with the latter. So also *delphinium hybridum* is thought to have sprung from *delphinium elatum* and *aconitum napellus*, by its combining together the features of both. But this spurious impregnation seems to be confined within very narrow limits, and takes place only among plants that are nearly related by natural affinity.

If a male plant is placed in the neighbourhood of a female plant which from its having been formerly insulated, had produced no perfect seed, or if the pollen of a male plant of the same species is conveyed to it from a distance, and sprinkled over the stigma, it will now produce perfect seed. A plant of the *datisca cannabina*, which came up in the garden of Linnæus, from seed about the year 1750, and which produced afterwards many flowers, yielded, however, no perfect seed, as the flowers happened to be all females. At last, however, in 1757, a parcel of seed was procured, from which a few male plants were obtained, that flowered in the following year. They were removed to a distance from the females, and when their flowers were ready to discharge the pollen, it was collected by means of shaking the panicle with the finger over a piece of paper, till it was covered with a fine yellow powder. The pollen thus obtained, was immediately carried to the female plants, which were growing in another part of the garden, and sprinkled over them, in consequence of which they now produced perfect seeds. But the best example of this kind yet exhibited, is that of the famous experiment of Linnæus upon the Berlin and Leipsic palms. About the period of the foregoing experiment, or rather a few years prior to it, there grew at Berlin an individual female palm tree which had never perfected any fruit, so as that no seeds would germinate, while there grew at the same time, at Leipsic, a male plant of the same species. Hence it occurred to Linnæus, that the impregnation of the female flowers of the former was still practicable, even by means of the pollen that might be procured, and carried from the male flowers of the latter. Accordingly, a flowering branch of the male plant was dispatched by post from Leipsic to Berlin, a distance of twenty German miles, and shook or suspended over the flowers of the female plant. The consequence was, that the fruit was ripened, and the embryo perfected, and young plants raised from the seeds. Again, if the male plant be removed from the vicinity of the female plant to which it had given fecundity, the fruit of the female plant is again produced imperfect as before. About the year 1755, there grew in the garden of M. de la Serre, at Paris, a female pistachio

tree, which blossomed every summer, but without producing any fruit capable of germinating; as this gentleman had frequently sown the seeds it yielded, in the hope of raising more plants, but without success. At last, however, he was advised by Jussieu and Du Hamel to endeavour to procure a male plant and place this near it. Accordingly a male plant was procured, in the following year, full of flowers, and placed near the female, the result being, as in other cases of a similar kind, that the seed now produced was capable of germinating when sown. But when the male plant was afterwards removed, the fruit of the female plant was found to be again incapable of germinating. In the month of April, 1752, Linnæus sowed a few grains of hemp seed in two different pots, in both of which it came up very well. In the one pot he left the male and female plants together, which flowered and produced fruit that was ripe in July; from the other pot he removed all the male plants as soon as they could be distinguished from the females, which grew indeed very well, and presented their long pistils in great abundance, as if in expectation of their mates. But when the calyxes were afterwards inspected about the time that the pistils began to decay through age, though they were large indeed, and luxuriant, yet the seed buds were brown, compressed, and membranaceous, without exhibiting any appearance of cotyledons or pulp. Two plants of *clutia tenella* were in like manner kept growing in a window in Linnæus's house, during the summer months, the male and female plants being in separate pots. The female plants abounded with flowers, not one of which proved abortive; the pot containing the male plants was after some time removed to a different window in the same apartment, and still the flowers that were protruded under such circumstances were found to be fruitful. The pot containing the male plant was at last removed into a different apartment, and the female plants left alone, after being stripped of all the flowers already expanded. They continued to produce new flowers every day, from the axils of every leaf, but they proved to be all abortive. For after remaining on the plant for the space of eight or ten days, till the foot stalks began to turn yellow, they all fell barren to the ground. Such is the amount of the great body of facts, resulting both from observation and experiment, on which Linnæus has established the doctrine of the sexes of vegetables, and on which the important and irresistible conclusion depends, that no seed is perfected without the previous agency of the pollen.

To complete this subject we must, however, allude to the objections which were raised to the theory of the sexuality of vegetables about the time when this theory was not yet completely establisheh by the foregoing accumulation of facts.

Camerarius, who had inferred the truth of the doctrine from the result of actual experiment, which he was indeed the first to institute on the subject, seems after all to have found cause to doubt the legitimacy of his conclusion, in observing that some of the female plants on which his experiments were made, such as hemp, spinach, and mercury, produced also ripe and perfect seeds, even when placed altogether beyond the reach of the influence of the male plants. This fact looked, no doubt, extremely hostile to the doctrine he was endeavouring to establish, and perhaps constituted to him an insuperable objection; but the fact has now been sufficiently accounted for, and consequently the objection obviated. For it has been ascertained, by means of more minute and accurate observations, that the fertile plants of the genera in question have often some latent male flowers interspersed among their female flowers, so that the former, though difficult of detection, are sufficient to secure the impregnation of the latter, even when the individual producing them is solitary. Tournefort, who denied the doctrine of the sexes altogether, though on insufficient grounds, admitted, however, the utility of the stamens in the economy of fructification, regarding them as organs both of secretion and excretion, the substance excreted being the pollen, and the substance secreted being a peculiar fluid that was conducted by the filaments to the germen. But if the pollen is merely an excrement, how comes it to be so very curiously organized? And if the stamens secrete a fluid which they afterwards conduct to the germen, by what means do they conduct it when placed on a different plant? Pontedera, who was one of the most zealous disciples of Tournefort, and willing to defend him, even when least defensible, not only adopted the opinions of his master on this subject, but endeavoured to establish them by additional argument, contending that if the stamens and pistils were even destined to the discharge of the functions ascribed to them by the sexualist, yet there are many cases of perfect fructification in which they could not possibly co-operate to the production of the effect. Adducing the example of the *umbelliferæ*, in which the style, as he rightly remarked, does often not appear till after the stamens have fallen. But although the styles remain often inconspicuous till the period assigned by Pontedera, yet the stigma is previously mature, and consequently capable of the necessary co-operation. But if the fact had been precisely what it appears to be in the objection, still it would have afforded no formidable argument against the doctrine of the sexes. For as the several flowers of the same plant, and much more the flowers of

different plants, do not all come to maturity precisely at the same time, the flower whose stamens have fallen before the maturity of its pistil, may still be impregnated by the pollen of another flower or plant with which the period of its maturity is identical, and to which it may be ambiguous. And in this way we may believe the impregnation of many flowers is effected, particularly in the case of the Indian corn, the barren flowers of which, upon the same plants, have generally quite decayed before the fertile flowers have burst from the bosom of the leaves, at least as it grows in this country, as also in the case of the *jatropha urens*, the barren flowers of which are generally protruded either several weeks sooner or several weeks later than the fertile flowers, and are consequently either decayed or not yet come to maturity at the time the style is perfect. But if the fertile flower should not be contiguous to the barren flower, the pollen may yet be wafted to it by means of the wind, which curious phenomenon may sometimes be distincaly seen. On the 14th June, 1808, says Dr Keith, as I was accidentally looking at a field of rye grass situated to the south of the spot on which I then stood, the atmosphere being clear, and the wind blowing gently from the west, I was surprised to observe a thin and sudden cloud, as if of smoke, a fine dust, sweeping briskly along the surface of the grass, and gradually disappearing. This cloud was soon followed by a second from a different quarter of the field, and that by a third, and so on in succession for several minutes. It was a general discharge of pollen from thousands of anthers bursting at the same moment, so that no stigma ready to receive the pollen could possibly fail of being supplied, either from the anthers proper to the flower of which it formed a part, or from those of some other flower discharging their contents into the general mass. The distance to which the pollen may be conveyed on a short exposure to the action of a fine atmosphere, is not likely to do it any damage. Linnæus kept some of the pollen of the *jatropha urens* in paper for more than a month, which even after that period fertilised the pistils over which it was shaken. Such were the doubts entertained by the sceptical prior to the elucidations of Linnæus, and indeed they arose almost naturally out of the darkness in which the subject was then involved. But as the elucidations of Linnæus, though capable of affording conviction to the minds of the impartial inquirer, were not able to subdue passions, or to eradicate prejudices imbibed by education, or excited by compassion, the doctrine of the sexes of vegetables met also with many opponents even in the time of Linnæus. The most zealous of them was Dr Alston of Edinburgh, who professing to be dissatisfied with every thing that had been said or done in support of the doctrine, made a show of refuting it by means of counter experiments, of which the most formidable are the following. Admitting the result of the experiment of the cutting off of the anthers before the ripening of the pollen, to be what Linnæus and others affirm the abortion of the seed, he will not allow that it authorises any conclusion in favour of the sexes of plants, because he thinks it is to be expected that a wound in any essential part of the plant, together with consequent loss of juice issuing from it, will occasion abortion in the seeds, and in confirmation of this presumption, he quotes an experiment of Malpighi, who found that the ripening of the seeds of a tulip was prevented by means of the putting off the petals before their expansion. But the two experiments are not at all of the same kind. In the latter, there was a material injury done to the flower in consequence of its being prematurely stripped of the covering of the corolla; in the former there was no material injury done to the flower, because the anthers were not cut off till after the natural expansion of the petals, in which case it is very well known that if the pistil is impregnated even with the pollen of another flower, the seeds will still ripen. But Alston does not even admit the fact that the stripping of a plant of its stamens, will render the seed abortive. Alleging in support of his opinion Geoffrey's experiments on maze, in which it was found that some of the ears ripened a few seeds even when the stamens were entirely cut off before the bursting of the anthers, together with a similar experiment of his own upon a solitary tulip, by which the ovary suffered nothing, but increased, and came to maturity quite full of seeds. Now the defect of the argument is, that we are not told whether the seeds were put to the proper test, that is, whether they were sown, and found capable of germination. The next counter experiment was made upon diæcious plants. Three plants of common spinach, which were removed before it could be told whether they were to be fertile or barren, to a distance of at least eighty yards from the bed in which they were raised, and from which also they were separated by several intervening hedges, proved in the end to be all fertile, and ripened plenty of seeds that germinated again when sown. A solitary plant of hemp also, that sprung up in Dr Alston's garden, having no other plant of the species within a mile of it to his knowledge, grew luxuriantly, and produced seeds that germinated also when sown. These experiments are contradictory no doubt, to the experiments of Linnæus, but they afford no argument against the doctrine of the sexes. For in the first place, it cannot be proved that some of the pollen from the spinach bed, or from a neighbouring male plant of hemp, might

not have reached the insulated plants by means of a favourable combination of circumstances; and in the next place, it is not certain that the plants in question were not furnished with some minute and latent male flowers, by which the impregnation might have been effected. The next most formidable opponent was Spallanzani. His first experiment was made upon the *ocymum basilicum*, an hermaphrodite plant, the anthers of several flowers being all cut off before the pollen was ripe, and the stigmas carefully secured from the access of the pollen of other flowers, in which case it was found that most of the seeds produced were evidently imperfect; though there were also a few that seemed to be completely matured by their exhibiting, on dissection, the same appearances as others that had been exposed to the action of the pollen. But when those apparently perfect seeds were put to the proper test, they were found to be in reality imperfect; they did not germinate when sown. This result was sufficiently discouraging, but it did not deter him from another attempt. The subject of his next experiment was from the class *monœcia*, the *cucurbita citrullus*, the male flowers of which were destroyed as soon as they made their appearance, and the female flowers, in order to prevent all suspicion of the access of pollen, were inclosed in bottles, luted to the stem by the neck so as to exclude even the external air. The seeds which were procured in this way, germinated and produced plants. This result was as favourable to Spallanzani's opinion as could be wished. But to give to the argument against the sexes all the weight he could, he now directed his attention to the class *diœcia*, selecting as the subject of experiment some plants of particular families, from which he obtained results equally favourable to his views. For after taking every precaution to secure the female plants from the access of pollen, as in the above example, seeds were still procured that germinated when sown. From all which experiments he was inclined to think that the pollen is not in any case essential to fecundation. If to these, however, we oppose the experiments of Linnæus, and others already detailed, the preponderance of facts is greatly in favour of the sexual theory. Even although the experiments instituted by Spallanzani were rather favourable to his views, yet he does not seem, after all, to put implicit confidence in them, thinking that the opposite doctrine may still be true, that the ripening of the seeds that were perfected without the pollen, might have been effected by means of a power, inherent in the female flowers, of propagating to a certain number of germinations without the assistance of the male, in the same way as Bonnet had shown that the aphis insect does, and as he had himself observed take place in some other plants which propagated in this way for three generations. Spallanzani suggests also the possibility of the fecundation of the ovary by means of some seminal principle residing in the pistil, and capable of supplying the place of the pollen as well as necessary in the case of monœcious and diœcious plants, to ensure the perfection of the seed. This conjecture is perhaps countenanced in some degree by Kœlreuter's account of the chemical properties of the moisture exuding from the stigma when ripe, which he represents as being precisely the same with the chemical properties of the pollen. But this is leaving the matter precisely as it was taken up; for if the suggestion of Spallanzani is true, then there exists at least a virtual sexuality in vegetables.

CHAP. XIII.

ORGANS OF FRUCTIFICATION.

Flowers exist in the incipient state in the bud long before the period of their evolution. If the scales of a leaf bud are taken and stripped off and the remaining part carefully opened up, it will be found to consist of the rudiments of a young branch terminated by a bunch of incipient leaves imbedded in a white and cottony down, being minute, but complete in all their parts and proportions, and folded or rolled up in the bud in a peculiar and determinate manner. This has been called the foliation of plants. If the scales of a flower bud are taken and stripped off, and the remaining part carefully opened up, it will be found also to consist of the rudiments of an incipient flower, exceedingly small and minute, but complete in all its parts. This operation was performed in the month of January, by Du Hamel, on the bud of a pear tree, and the following was the result. The scales, which were from twenty-five to thirty in number, were found to contain from eight to ten flowers, attached to a common foot stalk of half a line in length. The flowers in their general aspect resembled rose buds set with hairs. The petals were scarcely perceptible, but the filaments were distinctly visible, surmounted with white anthers. The pistils were not yet visible, but they became so in the following month, when the anthers had begun to assume also a tinge of red. The ovary was not distinguishable in the earlier dissection, but it became so before the evolution of the bud. Similar appearances may be seen by opening up the flower buds of almost any plant, long before the time of their natural evolution. The mezereon produces its flowers in the month of January or February; but if a bud be taken and dissected in the month of August preceding, the petals, the stamens, and

the enveloping of the young fruit may be all distinctly perceived. The peach tree produces its flowers in April, but if a bud is dissected in the month of February preceding, the whole of the parts of fructification may be perceived in miniature, wrapped up in the calyx by the overlopping of its divisions. The corolla is extremely small, but the stamens and pistils are very perceptible, and the pollen may even be discerned in the anthers. If a bud producing both leaf and flower, is taken and dissected in the foregoing manner, the rudiments of its future products may be also distinctly perceived long before the period of its evolution. A bud of the horse chestnut about the size of a pea, dissected in the winter, exhibited four branch leaves covering a flower like spike, consisting of upwards of sixty florets. Another bud opened in the spring, contained, amid sixteen scales, a pair of opposite leaves, with the divisions closely matted together by a fine down; within there was a flower spike, consisting of not less than a hundred florets closely crowded together, each enveloped by its downy calyx, which on being opened, disclosed the corolla, stamens, and pistil, with the rudiments of the future fruit distinctly visible in the ovary. The petals of the corolla, before their evolution, are wrapped up in a flower bud, like the young leaves of the plant in the leaf bud, and are also found to exhibit similar varieties of envolution.

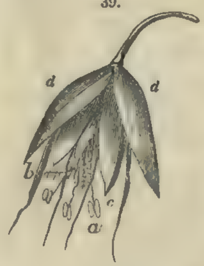
The flower, like the leaf, is a temporary part of the plant, and takes its rise either from the extremities of the branches immediately from the stem, or the root, and sometimes from a leaf. It is the apparatus appropriated by nature for the production of the seed, and in addition to this important end, it forms one of the most interesting objects in nature, being possessed of colour, odour, and in many cases, a nectareous juice, or honey; hence, it has been styled by Pliny "the joy of plants," *flos gaudium arborum.* When the flower is supported by a flower stalk, it is said, like the leaf, to be pedunculate; when the stalk is wanting, *sessile.* When the stalk branches out and supports a number of flowers, it is said to be *pedicillate.* Sometimes the flower is surrounded by a number of small leaves of a distinct form from the rest of those on the plant; these are named *bractea.* A complete or perfect flower consists of the *calyx* or cup, the *corolla* or coloured part, the *stamens* and *pistil;* many flowers, however, have no calyx, and others neither calyx nor corolla. All the monocotyledonous plants are destitute of a corolla. Linnæus gave the general name of *perianth* to the whole of the floral envelopes which surround the sexual organs. When the perianth is single, it is called calyx; when double, the innermost envelope is called the corolla. These floral envelopes, notwithstanding the delicacy of their texture, and the varied colours which they frequently exhibit, are in general nothing more than leaves with slight modifications. This is particularly the case in the calyx, which in many flowers is exactly like leaves.

38.

a, calyx; *b*, corolla; *c*, stamens and pistil.

The *calyx, a,* is the outer envelope, or cup, in which the flower rests; it is either single or formed of several leaves; which may be more or less distinct or divided. It is called, when it consists of a single piece, *monosepalous.* This always occurs when the calyx is united to the ovary; or in other words, when the ovary is inferior. It generally remains after the fecundation of the seed, and in many cases till it is ripe. When the calyx consists of several parts, it is termed *polysepalous.* This description commonly falls off immediately after fecundation, and frequently on the first expansion of the flower, as in the common poppy. The calyx is of various shapes, as pear shaped, urceolate, as in roses, inflated, campanulate, or bell shaped, cup shaped, cylindrical, &c. Generally the calyx is green, occasionally it is coloured, especially where there is no corolla.

39.



a, stamens; *b*, pistil; *c*, glume; *d*, *d*, lepicene.

The *glume, c,* is a chaffy membranaceous substance accompanying the flowers of grasses, and grains, and corresponds to the calyx of other plants, although not formed like a cup. Sometimes it is composed of one piece only, at other times of two distinct pieces or valves, and these valves vary in figure in different plants. The scale is another kind of calyx found in the willow and pine.

The *Corolla*, cut 38, fig. *b.* The corolla is the exterior envelope of the flower, investing the central parts, but invested by the calyx; the corolla, therefore, never exists unless when there is a double perianth of which it forms the interior part. It is generally of a finer and more delicate texture than the calyx, and is of all the parts of fructification the most showy and ornamental, being always, or with few exceptions, that which is the most highly coloured; hence commonly regarded as alone constituting the flower as well as that from which the flower imparts its rich perfume, delighting at the same time both the sight and the smell. To this the most elegant part of the fructification, the term corolla has been very happily applied by Linnæus, signify-

ing, as it does in the original, a crown or chaplet.

The corolla is *monopetalous*, or formed of one piece, as in the fox-glove, bind-weed, and deadly night-shade; or *polypetalous*, composed of several petals, as in cut 40, *d*, *d*, and in the rose, pink, wall-flower, and many others. The corolla is divided into the tube, the mouth, and the border; the petals into the claw and lamina, or border; the figures and numbers of the petals vary in different species. The calyx is regular when its incisions and divisions are equal to each other, and symmetrically placed; and *irregular* when its incisions are unequal, and its parts do not correspond, such is the snap dragon, hooded mill foil, &c.

40.

The monopetalous corolla assumes various forms, such as the tubular, campanulate, urceolate, or pitcher shaped, salver shaped, stellar.

The irregular monopetalous corolla is said to be two lipped, or *labiate* when separated into an

41.

a. *b*. *c*. *d*.

upper and under lip, as in thyme, balm, rosemary, fig. *a*, *b*; it is *personate*, or masked, when divided into two unequal lips, resembling somewhat the mouth of an animal, fig. *c*; urceolate or pitcher shaped, as in the heaths, fig. *d*. The polypetalous corolla may consist of two parts, as in enchanters, night-shade; or of three, four, five, or six petals.

The papilionaceous corolla is exhibited in the common pea, fig 42, when the petals are irregular, and so placed as to resemble the wings of a butterfly.

42.

a, calyx; *b*, corolla.

The petals may be opposite to the divisions of the calyx, and thus correspond with their surfaces, or they may alternate with these, and correspond to the divisions of the calyx.

The colour of the corolla is either a pure and beautiful white, as in the guelder rose and magnolia; or various shades of red, as in roses; or yellow, blue, violet purple, and other intermediate shades. Its use is evidently along with the calyx to protect the sexual organs, and ensure the deposition of the pollen on the pistil, and in most plants it disappears immediately after this office is performed. Yet, the corolla is by no means essential to the structure of a fruitful plant, as many classes are entirely destitute of such an appendage.

43.

a, ovary; *b*, style; *c*, stigma; *d*, filament; *e*, *e*, anthers.

The annexed cut exhibits the usual manner in which the sexual organs are contained within the corolla.

The *stamen* answers the same purposes in plants as the male organs in animals; in other words, it contains the substance by which the fecundation of the germs is effected. It is generally composed of three parts: 1. The *anther*, a kind of membranous bag, having a double internal cavity, formed of two cells in contact with each other; 2. The *pollen*, a substance commonly formed of small vesicular grains, which contain the parts necessary for fecundation; 3. The *filament*, a thread-like appendage by which the anther is frequently supported. Such are the three parts of which the stamen is usually composed. But of these parts two only are essential to it, the anther and the pollen. The filament is merely an accessory part of the stamen, and is accordingly often wanting, the anther being then directly attached to the body on which it is inserted, without the intervention of a filament. In this case the stamen is said to be *sessile*.

The essence and perfection of the stamen, consists in the presence of the anther. But in order that this organ may be fitted for performing the functions allotted to it by nature, it must not only contain *pollen*, but must also open, that the pollen may come into contact with the stigma; otherwise fecundation could not take place.

The number of stamens vary in the different families of plants. Some flowers have only one stamen, as the *hippuris* or mares-tail; others have two, as *veronica;* others three, as the grasses, and so on, till we come to an indeterminate number. The first classes of the Linnean system are determined by the number of stamens, the terms of which will be explained in the table to be afterwards given. The manner in which the stamens are inserted, afford also distinctive characters. Thus, if they are inserted in the receptacle, as in ranunculus, they are said to be *hypogynous;* if in the corolla, as in veronica, they are *epipetalous;* if in the calyx, as in the family epilobium, they are *perigynous;* and if in the ovary, as in the orchis family, they are called *epigynous.*

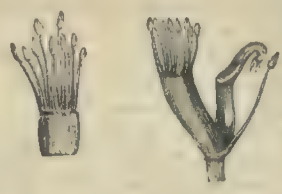
The relative proportions of the stamens to one another, and to the several parts of the flower,

is also a circumstance of material importance to the botanist. In the tulip, and in the generality of plants, they are nearly of the same length in the same flower; but there are some in which their lengths are unequal. This is the case in the genus *mentha*, (as peppermint) in which, out of four stamens, two are always shorter than the others. The same is the case in the classes *didynamia* and *tetradynamia;* in the latter, of six stamens two are always shorter, forming a remarkable character of the cruciform plant. If compared in their proportions with the other parts of the flower, the stamens are sometimes found to equal the calyx or corolla in their length, as in the genus *polygonum;* sometimes they are found to overtop it, and in other cases to fall short of it. In many flowers certain of the stamens are always abortive, as in Virginian spider-wort, sage, rosemary &c. The stamens, though very different in their shape and structure from the petals, exhibit, however, strong indications of being nearly allied to them, and seem in some cases, as in the flower of *nymphea alba*, or water lily, to run mutually into each other, the inner petals being partly stamen, or the outer stamens being partly petals. But in many flowers, particularly the polypetalous, the stamens are entirely convertible into distinct petals, and are often so converted either in part or in whole. In the former case the flower is said to be double, in the latter case it is said to be full. But this singular conversion of stamens into petals, is regarded by the botanist as altogether an aberration from the laws of vegetable economy, and is found to occur but seldom except in consequence of culture. The anemone, ranunculus, and rose, when cultivated in our gardens, afford examples of the flowers of this description. They are more showy indeed, and more generally admired than the flower in its natural state, and are consequently the object of the peculiar care of the florist; but they are regarded by the botanist as being only vegetable monsters.

The *filament*, *d*, is the elongated, slender, and threadlike stalk which supports the anther. It is not an essential part of the stamen, being in many cases absent. According to its various forms it is distinguished into flattened, wedge-shaped, awl-shaped, capillary. The anther is generally attached to the tip of the filament; but sometimes the latter is prolonged above the insertion of the anther. The stamens are in general free and unconnected with each other; but in certain cases they are more or less united by means of the filaments.

When the filaments are all connected together, either by the sides or at the base, they are said to be *monadelphous*, as in the mallow, fig. *a*. When the filaments are united into two distinct portions, they are said to be *diadelphous*, as in the common pea and fumitory, as fig. *b*. When

44.



a b

united into three or more bundles, they are termed *polydelphous*.

The colour of the filament is generally white, as in the convolvulus; but in the peach it is spotted, and in the medlar tree red. In some stamens the filaments are elastic, unbending themselves with considerable force as the corolla expands, as in the genus *Urtica;* and in some they are susceptible to the action of external stimuli, as in those of the barberry, which, if touched with the point of a needle or other fine instrument on the inner side, and near the base, will spring forward immediately with a sudden jerk to the centre of the flower.

The *anther*, *e*, is the essential part of the stamen, and contains the pollen or fecundating powder. It is generally formed of two membranous bags attached to each other by their sides, joining or united by an interposed body. Each of these bags or cells is divided internally into two parts by a partition, which cells open at the period of fecundation to allow the pollen to escape.

Sometimes the anther consists of only one cell, as in the hazel, mallow, and pine; more rarely there are four cells, as in *butomus umbellatus*. Each of the cells have on one side a longitudinal groove, where the opening takes place. Sometimes the pollen escapes by pores or slits in the summit of the anther, as in the heaths, the potatoe, &c.; in other cases their pores are furnished with immovable valves, as in the barberry, laurel, and *epimedium alpinum*. In fig. 45, *a a*, are the pores in the anther; *b b*, the movable and elastic valves.

45.

46

The anther is attached to the filament in various ways, as by its base, middle, or summit. The anthers sometimes are united together so as to form a continuous tube. This is the case in the family of the *syngenesia*, as the daisy, marygold, thistle, &c.

The *Pollen*, or the substance contained in the cells of the anther, and which is subservient to fecundation, generally presents the appearance of a powder, composed of extremely minute

grains. Sometimes it is in solid masses of greater or less size; but as, in this state, it occurs in only a few plants, we shall first examine the pollen in the powdery form.

Previous to the improvement of optical instruments, the knowledge which had been obtained respecting the varied forms of the grains of pollen, and especially respecting their internal structure, was extremely vague. A great diversity had indeed been perceived in those which had been examined with powerful lenses, but their differences had been pointed out without deriving from them any references that might tend to the advancement of science. The structure of the pollen had also engaged the attention of most of the botanists, who had long disputed, without coming to any settled determination, respecting the internal composition of bodies of so elementary a nature. The microscopic examination of the pollen was therefore a subject that required revision, and which could not fail to attract the attention of modern observers. The grains of the pollen are utricles of various forms, having no adhesion to the anther at the period of maturity, and containing a multitude of granules of extreme minuteness. The utricular membrane is sometimes smooth, sometimes marked with eminences or asperities. Sometimes it presents little flat surfaces or prominences symmetrically arranged. When the pollen is perfectly smooth at its surface, it is not at the same time covered with any viscous coating, whereas the slightest eminences are indications of this adhesive covering. The papillæ, mammillary eminences, &c., which cover certain grains of pollen, are true secreting organs, of which the viscous and usually coloured envelope with which they are invested is the product. The powdery pollens may therefore be arranged under two principal orders, the *viscous* and the *non-viscous* pollens.

M. Guillemin discovered, by extensive observation, that the nature of the grains of pollen is the same in each natural family of plants; or, in other words, that viscous and non-viscous pollens never occur together in the same family. He has found, moreover, that all the genera of a family present only modifications in the forms of their grains of pollen; although families very remote from each other in respect to other characters, agree in having the same kinds of pollen. We shall here content ourselves with describing the nature and forms of this organ in a few remarkable families.

The pollen of the Mallow and Convolvulus families is formed of papillar spherical grains, of a silvery white colour. In the cucumber, they are spherical, papillar, and of a beautiful gold-yellow. Those of the tribe of *heliantheæ*, in the family of *synanthereæ*, are also spherical, papillar, and of a fine orange-yellow. The tribe, or rather order, of the *cichoraceæ*, presents spherical grains, which are viscous, but are bounded by minute plain surfaces. In *cobœa scandens*, the pollen is covered with mammillar eminences, each surmounted by a shining point. The pollen of the genus *phlox* very much resembles that mentioned last; and this is a circumstance corroborative of the opinion of those who consider the two genera as belonging to the same natural family.

The families in which grains that are not viscid are found are very numerous. As in the potatoe, gentian, grasses; and the grains in these have always an elliptical form, and are marked with a longitudinal groove. Their usual colour is yellow, although they are sometimes red, as in *verbascum*. In the pea tribe, the pollen, although not viscous, is of a very distinct cylindrical form.

When grains of pollen which are not viscous are subjected to the action of water, they instantly change their form, which, from being elliptical, becomes perfectly spherical. The viscous grains first lose their coating, then burst more or less quickly, and project a fluid denser than water, and in which are seen moving myriads of minute grains, which are rendered visible by their greenish colour, when they are magnified to several hundred diameters. Amici saw a grain of pollen, in contact with a hair of the stigma, burst, and project a kind of bowel, in which the minute grains circulated for more than four hours. Gleichen, who had already observed the granules contained in the grains of pollen, considered them as performing the principal part in the act of fecundation; and Guillemin, reasoning from the resemblance of these organs to the spermatic animalcules of animals, is inclined to adopt the same opinion.

Such was the state of our knowledge respecting the nature and organization of the grains of the pollen, when Brongniart undertook his examination of the generation of vegetables. His opinion respecting the nature and organization of the grains of pollen is as follows:—On examining the interior of the cells of a yellow anther in a flower-bud, long before its expansion, it is seen to be filled with a cellular mass distinct from the walls of the cells. By degrees the cellules of which the cellular mass is composed, and which are generally very small, separate from each other, and at length form the granules, which are named pollen. Sometimes these particular cellules or grains of pollen are enclosed in other larger vesicles, which become torn, and of which traces may still be perceived.

Each grain of pollen, whose form, as has already been remarked, is very variable, presents a uniform organization. It is composed of two membranes, the one external, thicker, and furnished with pores, and sometimes more or less

prominent appendages; the other internal, thin, transparent, and having no adhesion to the first. When submitted to the action of water, the inner membrane swells, the outer bursts at some part of its surface, and through the opening thus formed there issues a tubular prolongation, which forms a kind of bag, first observed by Needham. Sometimes two prolongations issue, at two opposite points. The cavity of the inner membrane is filled with spherical granules, of extreme minuteness, which appear to perform the most important part of the act of fecundation.

The pollen of the families Asclepiadeæ and orchideæ presents very remarkable modifications. In several genera of these two families, all the pollen contained in a cell is united into a body, which has the same form as the cell in which it is contained. To this united pollen is given the name of *pollen-mass*. When the pollen is thrown on red-hot charcoal, it burns and flames with rapidity. In many plants, it diffuses an odour, bearing the most striking resemblance to the substance in animals to which it is compared, as is very distinctly observed in the chestnut and barberry.

The pollen, when it begins to be developed, and long before the expansion of the flower, presents itself under the form of a cellular mass, sometimes covered with an extremely thin membrane, which, however, has no attachment to the walls of the cavity. The utricles of which this mass is composed, are at first very intimately united together. Some scattered granules are perceived in their interior. By degrees the utricles separate, the granules which they contain unite, and by their successive development, soon burst the utricles, assume the form which they are to retain, and finally become grains of pollen. It will be seen that this mode of development is perfectly similar to that of the cellular tissue, which we described when treating of the elementary part of vegetables.

The *pistil* is the female organ in plants, cut 43. It almost invariably occupies the centre of the flower, and is composed of three parts, the *ovary a*, the *style b*, and the *stigma c*.

In most cases, we find only a single pistil in a flower: as in the lily, the hyacinth, and poppy. At other times, there are several pistils in the same flower; as in the rose and ranunculus. The pistil, or pistils, when there are more than one, are often attached to a particular prolongation of the receptacle, to which the name of *gynophorum* is given, and which does not essentially belong to the pistil, but remains at the bottom of the flower when the pistil is detached. When there are several pistils in a flower, it is not unusual to see the gynophorum becoming thick and fleshy. This is particularly observable in the raspberry, and strawberry. The part of the latter which is pulpy and sweet, and which is eaten, is merely a very large gynophorum; and the little shining grains which cover it are so many pistils. It is easy to satisfy one's self as to the nature of these different parts, by following their gradual development in the flower.

The *base* of the pistil is always represented by the point at which it is attached to the receptacle. The *summit*, on the other hand, always corresponds to the point where the styles or the stigma are inserted into the ovary.

The *ovary*, fig. *a*, always occupies the lower part of the pistil. Its essential character is, that when divided in the longitudinal or transverse directions, it presents one or more cavities, named *cells*, in which are contained the rudiments of the seeds, or the *ovules*. It is in the interior of the ovary that the *ovules* acquire all their development, and are converted into *seeds*. This organ may therefore be considered, with respect to its functions, as analogous to the ovary and uterus in animals. Its usual form is egg-shaped; but it is more or less compressed and elongated in certain families of plants, as in the Cruciferæ, Leguminosæ, &c. The ovary is generally *free* at the bottom of the flower; in other words, its base corresponds to the point of the receptacle, into which are inserted the stamina and the floral envelopes, although it does not contract any adhesion with the calyx; as is observed in the hyacinth, the lily, and tulip. Sometimes, however, the ovary is not met with in the bottom of the flower, but seems to be placed entirely beneath the insertion of the other parts; in other words, it is united in every part of its circumference with the tube of the calyx, its summit alone being free in the bottom of the flower. In this case, the ovary has been named *adherent* or *inferior*, to distinguish it from that in which it is *free* or *superior*. The genera *Iris*, *Narcissus*, *Myrtus*, and *Ribes*, have an inferior ovary.

47.

o, ovary of gooseberry; *p p*, magnified ball of pollen.

When this organ, therefore, is not met with at the bottom of the flower, but when the centre of the latter is occupied by a style and a stigma, it will be necessary to examine if there be not at the bottom of the flower a particular bulging, distinct from the top of the peduncle. If this enlargement, on being cut across, presents one or more cavities, containing ovules, it is clear that there is an inferior ovary.

The position of the ovary, considered as to its being *inferior* or *superior*, furnishes the most valuable characters for grouping genera into natural families. Whenever it is inferior, the calyx is necessarily *monosepalous*, since its tube

is intimately united to the circumference of the ovary. Sometimes it is not entirely inferior, but is free in some portion of its upper part, a third, a half, or two-thirds. These different gradations are observed in the saxifrages.

There is, however, a position of the ovary which, although almost always confounded with the inferior, requires to be distinguished from it. It is when several pistils, existing together in a flower, are attached to the inner wall of a calyx which is very narrow at its upper part, so that at first sight it might seem to represent an inferior ovary. These ovaries are named *parietal*, as in the genus Rosa, and many other plants of the same family.

The ovary is *sessile* at the bottom of the flower when it is not raised upon any peculiar support; as in the lily and hyacinth. It may be *stipitate*, when it is borne upon a very elongated base; as in the caper. When cut across, the ovary often presents a single internal cavity or *cell*, containing the *ovules*. In this case it is said to be *unilocular*; as in the almond, the cherry, and the pink. It is named *bilocular*, when it is composed of two cells; as in the lilac, the toadflax, and the foxglove. *Trilocular*, when composed of three. *Multilocular*, when it presents a great number of cells; as in the water-lily.

Each cell may contain a number of ovules, varying in different plants. Thus there are cells which never contain more than a single ovule, and others which contain two. In some cases, each cell contains a great number of ovules, as in the tobacco, the poppy, &c.; but these ovules may be variously disposed. They are not unfrequently regularly superimposed upon each other, along a longitudinal line; as in *aristolochia sypho*.

Ovules, when fecundated, become seeds; but it frequently happens that a certain number of them regularly become abortive in the fruit. Several of the partitions are even sometimes destroyed and disappear.

The *style* is the filiform prolongation of the summit of the ovary which supports the stigma, cut 43, *b*. Sometimes it is entirely wanting, and then the stigma is *sessile*, as in the poppy and tulip. The ovary may be surmounted by a single style, as in the lily, and the pea family; by two styles, as in the umbelliferæ; by three styles, as in the way-faring-tree; by four, as in the *parnassia;* or by five, as in the *statice, linum*. In other cases, again, there is only a single style for several ovaries; as in the *apocineæ*. The style almost always occupies the highest part of the ovary; as in the cruciferæ, liliaceæ, &c. It is then said to be *terminal*. It is named *lateral* when it arises from the lateral parts of the ovary; as in most of the families of roses, and the genus *Daphne*. In some much rarer cases, the style appears to spring from the base of the ovary. It then obtains the name of *basal* or *basilar style*. It has this position in the lady's-mantle, and the bread-fruit tree. Sometimes also, the style, in place of springing from the ovary, seems to arise from the receptacle; as in the labiatæ, and certain boragineæ. The style may be *included*, that is, contained within the flower, so as not to appear externally; as in the lilac, and the jasmine. Or it may be *protruded*, as in red valerian. The forms of the style are not less numerous than those of the other organs which we have already examined. Although it is generally slender and filiform, yet, in certain plants, it has quite a different appearance. It sometimes seems as if jointed to the summit of the ovary, so as to fall off after fecundation, leaving no traces of its presence; as in the cherry and plum. In this case, it is named *caducous*. Sometimes, on the contrary, it is *persistent*, when it remains after fecundation. Thus in the box, and the anemone and clematis, the style continues, and forms part of the fruit. Lastly, it sometimes not only remains after fecundation, but continues to increase in size; as in the pasque-flower.

The *Stigma* is the usually glandular part of the pistil, placed at the summit of the ovary or style, and destined to receive the influence of the fecundating substance, cut 43, *c*. Its surface is generally uneven, and more or less clammy. The stigma, considered in an anatomical point of view, is composed of elongated utricles, converging from the surface of the stigma towards the style, and loosely attached to each other by a mucilaginous substance. These utricles are generally naked, although, in some cases, they are covered by a very thin and transparent membrane. The number of stigmas is determined by that of the styles, or of the divisions of the style, the former always corresponding to the latter. The stigma is *sessile*, or directly attached to the summit of the ovary, when the style is wanting; as in the poppy and tulip. There is only *one* stigma in the cruciferæ, leguminosæ, primulaceæ; *two* in the umbelliferæ and a great number of grasses. *Three* in the iris, the genera *Silene*, *Rheum*, *Rumex*; *five* in the flax; *six*, and even a greater number, in many other plants, such as the mallows. The stigma is generally *terminal*, or situated at the summit of the style or ovary; as in the lily and poppy. It is *lateral* when it occupies the sides of the style, or, when that part is wanting, of the ovary; as in the ranunculus and plane-tree. With respect to the *substance* of which it is composed, it is *fleshy* when thick, firm, and succulent; as in the lily. *Glandular*, when evidently formed of small glands, more or less approximated to each other. *Membranous*, when flat and thin. *Petaloid*, when thin, membranous, and coloured like the petals. According to its *form*, the stigma may be *glo-*

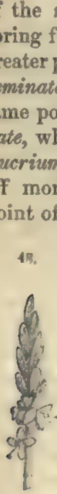
bular or *capitate*, rounded like a little head; as in the cowslip, belladonna, and marvel of Peru. *Hemispherical*, having the form of a hemisphere; as in the yellow henbane. *Discoid*, flat, broad, and in the form of a shield; as in the poppy. *Claviform* or *club-shaped* as in *jasione montana*. *Capillar* or *filiform*, slender and very elongated; as in the maize. *Linear*, narrow and elongated; as in the *campanulæ* and many caryophylleæ. *Trigonal*, having the form of a three-sided prism; as in the wild tulip. *Trilobate* or *three-lobed*, formed of three rounded lobes; as in the lily. *Stellate*, flat and cut into several lobes, so as to resemble a star; as in the *ericineæ*, and the genus *Pyrola*. *Umbilicate*, having a depression in its centre; as in the lily. *Semilunar* or *crescent-shaped*, as in the yellow fumitory.

Having described the parts of a single flower, we shall now allude to the manner in which these are placed on the stalk, and frequently grouped together.

The term *Inflorescence*, is applied to designate the general disposition or arrangement which the flowers affect upon the stem, or the other organs which support them.

The flowers are said to be *solitary* when the plant produces only one, or when they come off one by one from different points of the stem, at some distance from each other; as in the tulip and the common garden rose. They are *terminal* when situated at the top of the stem; as in the tulip. *Lateral*, when they spring from the sides of the stems or branches. *Axillar*, when they spring from the axilla of the leaves, as in the greater periwinkle, and the ivy-leaved speedwell; *geminate*, when they come off in pairs from the same point of the stem, as in *viola biflora*; *ternate*, when they come off three together, as in *teucrium flavum*; *fasciculate*, when they come off more than three together from the same point of the stem or branches, as in the cherry.

48.



1. When the flowers are arranged upon a common stalk or axis, which is simple or not branched, whether they be sessile or pedunculate, and whether the peduncle be straight or inclined, they form a *spike*, and are accordingly described as *spiked*, as in wheat, barley, rye, the ribwort plantain, the black currant, the barberry, and the genus *orchis*.

2. If the common peduncle branches several times, and in an irregular manner, this arrangement takes the name of *raceme*, and the flowers are described as being *racemose*, as in the vine.

The characters which most authors have given as distinguishing the spike from the raceme are so uncertain, that it is almost impossible to discriminate between these two modes of inflorescence. Thus, some say that the flowers are sessile in the spike, and pedunculate in the raceme; and others, that the raceme is always pendulous, and the spike erect. Perhaps the best distinction is, that the axis of a spike is always simple, whereas that of a raceme is always branched.

3. When the common axis is erect, and the peduncles are irregularly divided into pedicels bearing the flowers, if the whole assumes a nearly pyramidal form, it obtains the name of *thyrsus*, as in the lilac, the privet, and the horse-chestnut. This species of inflorescence is closely allied to the *raceme*.

49.

4. The flowers are said to be disposed in a *panicle*, or to be *paniculate*, when the common axis is branched, and its secondary divisions are greatly elongated and widely separated. This species of inflorescence belongs almost exclusively to the gramineæ: such, for example, are the male flowers of the maize.

50.

5. The flowers are *corymbose*, or are disposed in a *corymb*, when the peduncles and pedicels spring from different points of the upper part of the stem, but all attain nearly the same height; as in common milfoil.

6. The *cyme* is produced, and the flowers are said to be *cymose*, when the peduncles proceed from the same point, the pedicels being unequal, and coming off from different points, but raising all the flowers to the same height; as in the elder and cornel.

51.

7. The flowers are *umbellate* when all the peduncles are equal, spring from the same point of the stem, diverge, and branch into pedicels, which again come off from the same point, so that the general mass of the flowers represents a convex surface, like an expanded umbrella. This disposition is observed in the whole natural family of the umbelliferæ; for example, in the carrot, hemlock, opoponax. The peduncles form collectively an *umbel*; and each group of pedicels constitutes an *umbellule*. At the base of the umbel, there is very frequently observed an involucre; and at the base of each umbellule an involucel; as in the carrot. At other times, the involucre is wanting, while the involucels are present; as in chervil. Lastly, both involucre and involucels may be absent; as in *pimpinella and saxifraga*.

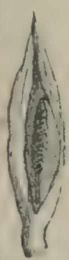
8. The flowers are *sertulate*, when the peduncles are simple, spring all from the same point, and attain nearly the same height; as in the flowering rush, most of the species of *allium*, the genus *primula*, &c. This kind of inflorescence has been referred to the umbel; but it differs so much from that species as to deserve a name of its own.

9. The flowers are disposed in a *whorl* or are *whorled* or *verticillate*, when they come off around the stem at the same height; as in mare's tail.

52.

10. The *Spadix* is a species of inflorescence, in which the common peduncle is covered with unisexual flowers, which are naked, in other words, destitute of a proper calyx, and generally distinct and separated from each other; as in *arum maculatum, caltha palustris*, &c. Sometimes, however, there are observed scales, which separate the flowers; but these cannot be considered as calyces, as they spring from the substance of the peduncle itself, of which they appear to be appendages, and are always situated beneath the point at which the flowers are attached; as in certain species of pepper. The spadix is peculiar to the monocotyledonous plants, and to the different species of *piper*. Sometimes it is naked, in other words, destitute of a general envelope; as in the genus just mentioned. At other times, it is enveloped in a spatha; as in the aroideæ, and certain species of palms.

53.



11. The *catkin* is a kind of inflorescence, in which unisexual flowers are inserted upon scales which, in some measure, perform the office of a peduncle. Flowers so arranged are named *amentaceous*. Of this kind are the male flowers of the chestnut and hasel, the male and female flowers of willows, &c. This species of inflorescence is that observed in a whole family of plants, composed of trees of various sizes, and which are named *amentaceous*. Of this kind are willows, poplars, alders, the birch, the hornbeam, the oak, the beech.

54.

All plants do not flower at the same period of the year. There are, in reference to this circumstance, very remarkable differences, which depend upon the nature of the plant, the influence of heat and light, and the geographical position of the vegetable. Were they to come out all in the same season, and at the same period, they would disappear too soon, and vegetables would remain too long destitute of their greatest beauty. Even winter, notwithstanding the cold which accompanies it, is not without flowers. The snowdrop, the hellebores, and the mezereons, unfold their flowers when the ground is still covered with snow. These examples, however, may be considered as exceptions to the general order. Cold, in fact, appears to oppose the growth and expansion of flowers, whereas a gentle and moderate heat favours and maintains them. Accordingly, in countries where the temperature continues in a mean state the whole year, a kind of perpetual spring prevails, and the earth is always covered with new flowers. In the temperate parts of Europe, it is in spring, when a gentle and vivifying heat has succeeded to the cold of winter, that the flowers gradually separating their envelopes, expand and disclose their beauties to our view. The months of May and June are those which see the greatest number of flowers expand.

According to the season in which they develope their flowers, plants have been distinguished into four classes:—1. *Vernal*, those which flower during the months of March, April, and May; such as violets, primroses, &c. 2. *Æstival* or summer plants, those which flower from the beginning of June to the end of August. These constitute the great majority of plants. 3. *Autumnal*, those which expand their flowers from September to December. Of this kind are many species of *aster*, and meadow saffron. 4. *Hibernal* or winter plants, those which flower from about the middle of December to the end of February; such as many mosses and jungermanniæ, the snow drop, black hellebore.

From the consideration of the period at which different plants produce their flowers, Linnæus formed his Calendar of Flora. For, there are many plants whose flowers always appear regularly at the same period of the year. Thus, in the climate of Paris, the Christmas rose flowers in January; the hazel and mezereon in February; the almond, the peach, and the apricot, in March; the pear, tulips, and hyacinths, in April; the lilac and the apple in May.

Not only do the flowers show themselves at different periods of the year, in different plants, but there are many flowers which open and close at determinate hours of the day, while some expand only at night. Thus the marvel of Peru opens its flowers only when the sun has sunk beneath the horizon. Hence flowers are distinguished into *diurnal* and *nocturnal*. The latter are much less numerous than the former. There are even flowers which have the habit of opening and closing at certain periods of the day, with so much regularity, that one may tell the hour by them. Linnæus, who was so ingenious in detecting the most interesting circumstances respecting flowers, made use of the periods at which some species are well known to expand, for the purpose of forming a table, to which he

gave the name of *Flora's Timepiece.* In this table, the plants are arranged according to the hour at which their flowers expand.

The state of the atmosphere appears to have a decided influence upon the flowers of certain plants. Thus, *Calendula pluvialis* closes its flower when the sky is overcast, or when a thunder-storm threatens to burst. *Sonchus sibiricus*, on the other hand, opens and expands only when the weather is hazy and the atmosphere loaded with clouds. The light of the sun appears to be one of the causes which acts most powerfully upon the expansion of flowers. Its absence produces a kind of sleep in flowers, as it does in the leaves of the family of Leguminosæ. By very ingenious experiments, Bory de St Vincent succeeded in causing to flower certain species of oxalis, the flowers of which never expanded naturally, by illuminating them strongly at night, and collecting upon them the rays of light by means of a lens.

The duration of flowers also exhibits some very remarkable differences. Some expand in the morning, and are withered before the end of the day. Such flowers are called *ephemeral.* Of this kind are the most of the species of *Cistus*, *Tradescantia virginica*, some species of *Cactus*, &c. Others, on the contrary, retain their splendour unimpaired for several days, often even for several weeks. Lastly, there are flowers whose colour varies at the different periods of their development. Thus the Hortensia begins with having green flowers. By degrees they assume a beautiful rose-colour, which, before they are entirely faded, becomes of a more or less deep blue.

Nectaries. By the general name of *Nectaries* Linnæus designated not only the glandular bodies which are observed in certain flowers, and which secrete a sweet or *nectareous* fluid, but also all the parts of the flower which, presenting irregular and unusual forms, appeared to him not to belong to the floral organs properly so called, that is, to the pistil, stamina, or floral envelopes. It may easily be conceived, that the great extension given by Linnæus to the term *nectary* could not but render it extremely vague. Indeed it is almost impossible to give a strict definition of it, as employed by him. A few examples will show the truth of our assertion.

Whenever one of the constituent organs of the flower presented some irregularity in its form or development, or some alteration of its usual aspect, Linnæus called it a nectary. It will readily be imagined that, in this manner, he must have confounded a multitude of organs very different from each other. Thus, in the columbine, Linnæus describes five nectaries in the form of recurved spurs, hanging between the five sepals. In the larkspur there are two which are prolonged into a point at their hind part, and are contained in the spur which is observed at the base of the upper sepal. In the hellebores we find a great number of nectaries, which are tubular and two lipped. Now, these alleged nectaries of the hellebores, columbines, and in general of all the other genera of the family of ranunculaceæ, are nothing but the petals. In the tropæolum, the nectary is a spur which arises from the base of the calyx. In the toad-flax, this nectary or spur is a prolongation of the base of the corolla. This is also the case in the violet, and balsamine.

Linnæus also gave the name of *nectaries* to masses of glands placed in different parts of the flower. Accordingly, he confounded the *disks* under that name; as in the cruciferæ, umbelliferæ, and rosaceæ. In the lily, the nectary has the form of a glandular groove placed at the internal base of the divisions of the calyx. In the genus *iris*, it is a tuft of glandular hairs, placed on the middle of the outer divisions of the calyx. In the grasses, the nectary is composed of two small scales, varying greatly in form, and situated on one side of the base of the ovary. These two scales or paleolæ form the *glumella*, an organ which performs no secretion. In the orchideæ, the nectary is the lower and inner divisions of the calyx, which other botanists, and Linnæus himself, have designated as the *lip.* If it be necessary to retain the term *nectary*, it should be exclusively applied to the little masses of glands situated on different parts of the plants, and destined to secrete a sweet juice, care being at the same time taken not to confound these bodies with the different kinds of disk, which are never secreting organs. By this means the uncertainty and confusion which the term carries with it might be avoided, and it would be restored to its true signification.

CHAP. XIV.

CRYPTOGAMIC FRUCTIFICATION.

Having described the floral organs of the more perfect plants, we now proceed to exhibit a view of the corresponding organs in the cryptogamic families, in which we shall find the parts much less complete, and in some cases, almost invisible.

Ferns. As this class of vegetables are destitute of conspicuous flowers, so they were at one time thought to be destitute also of seeds, and propagated nobody could tell how. Hence the common opinion so prevalent in ancient times, as to the nonentity of fern seed; an opinion that is scarcely even in the present day exploded among the vulgar, though shown by botanists to be entirely erroneous: the fruit or seed of ferns being not only visible to the naked eye, at least

in its aggregate mass, and even the individual seeds by the assistance of the microscope. The former must have been often seen though not attended to by ancient botanists; and the latter are said to have been first discovered by Cole and Swammerdam, about the year 1670, as well as distinguished from the capsules in which they are contained. It was still possible, however, that these naturalists might have been mistaken, as ferns had not yet been propagated by the sowing of their seeds. But the experiment was at last instituted in the year 1789, by two English botanists, and the result was, in each case, conformable to expectation, ferns being obtained from two respective sowings. The reality of fern seed being thus shown, the next object of the botanist was that of the discovery of the parts of the flower which had produced the seeds, the existence of which was inferred from analogy. But in pursuit of this object, it cannot be said that botanists have even yet been completely successful. For although Hedwig, that most able and accurate of all investigators, has indeed detected the parts of the flower in a variety of families, or at least, organs, which he presumes to be the constituent parts of the flower; yet, there seems to be still some considerable degree of doubt among botanists with regard to the value of some of his conjectures, and a consequent want of acquiescence in the legitimacy of some of his conclusions. But where the parts of the flower have not yet been detected, the botanist can at least direct his attention to the mode of fructification, and to the fruit produced. In some families, the fructification is placed near the root, as in the *pilularia* and *isoetes*, which are generally regarded as ferns, though the parts of the flower are so obvious as to render it doubtful whether they should not be transferred to the class of conspicuous flowers, rather than to that of the cryptogamic. In the *pilularia* the flowers issue from the bosom of the leaves, which spring from the root, and consist of a receptacle or calyx, anthers, and pistils, ascertainable by the aid of the microscope; the seeds being small and globular bodies lodged in the receptacle, covered with a fine membrane. In the *isoetes* the flowers are immersed in the base of the leaf or frond, and consist also of a receptacle or calyx, anthers, and pistils, as seen by a good magnifier, the seeds being small globular bodies, lodged in a capsule. In the family *Lycopodium*, the parts of fructification issue from the axis of the leaves (or are axillary); they exhibit, however, no parts exactly analogous to stamens or pistils, but consist of kidney-shaped capsules containing many minute seeds. In the family *Equisetum*, the fructifications consist of a succession of whorls of target-shaped substances, attached horizontally, and condensed into a club-like spike, terminating the stem; these targets being considered by Hedwig as forming each a calyx to the under surface, of which are attached several tubular cells containing stamens and pistils, and ultimately, upon becoming capsules, containing the seed.

85.

In *Ophioglossum* and *Osmunda*, in which the fructifications are also in spikes issuing from a leaf, the same botanist has discovered what he regards as both stamens and pistils. The capsules, however, are easily discerned, being of a globular figure, arranged in two rows, and opening crossways when ripe, with many minute seeds. In the former, the spike is simple; in the latter, it is branched. But, in by far the greater number of ferns, the flowering parts are in the back of the leaf, as seen in fig. *a*.

In these also, Hedwig discovered what he believes to be the parts of the flower; not indeed, including any thing like the calyx and corolla, but stamens and pistils only. If a frond of any of the dorsiferous ferns, as they are termed, is taken at a very early period of its growth, and carefully unfolded, there may be seen, with the assistance of a good microscope, dispersed over its under surface, but chiefly over that of the mid-rib, and sometimes also over the upper surface, a number of small globular bodies, which, when put into a drop of water, and placed under a high magnifying power, are found to consist of a small pedicle supporting a minute globule, filled with a granulated mass. These Hedwig regards as stamens, partly from the analogy of their figure, and partly from their disappearing in the mature state of the plant, as the stamens in other plants disappear before the fruit ripens. The pistils he describes as globules, sitting or supported upon pedicles, which are ultimately converted into the capsules that contain the seed; but without specifically determining the stigma. Bernhardi, a later writer than Hedwig, and an observer of great accuracy, has introduced a different theory, founded upon a different view of the subject. He regards the white speck discoverable upon the upper surface of the frond, which is opposite to the black spot or patch, on the under surface, as the stigma of the dorsiferous ferns; and the small globular bodies situated on the edge of the frond, as the stamens. The fruit is, however, easily distinguishable by the aid of a microscope, each individual consisting of a capsule, surrounded by an elastic and jointed ring, *b*, opening transversely when ripe, and discharging the sporules *c*, consisting of small minute globules. The fruits of all these ferns are so nearly alike in aspect, as to present few distinctive characteristics to the

practical botanist. Besides the capsule already described as containing the seed, the fructification of these ferns is also generally accompanied with an additional integument, called the *indusium*. This is a thin and membranous substance, covering the groups of capsules till the period of the maturity of the seed, each group having its separate covering or indusium, which originates, for the most part, in the nerves or veins of the leaf; but sometimes also in the margin. In some plants it is circular, in others longitudinal; in some it consists of one valve, in others of two, which, when the seed is mature, burst open, sometimes towards the nerves, and sometimes towards the margin, but in plants of a similar habit uniformly in a similar manner.

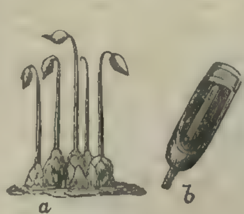
Mosses. The fructification of the mosses, though extremely elegant in its structure, is yet, at the same time, so extremely minute, as to be seldom recognized by the common observer; even by botanists it was long overlooked, or at the most but imperfectly investigated. The ancients, who believed in the doctrine of spontaneous generation, regarded the mosses as a tribe of plants originating in the putrefaction of other vegetables, or in the accidental concourse of generative particles, collected together by the alluvium of rains in rivers; and, consequently, as producing no flower or fruit. The earlier botanists of modern times seem to have regarded them in much the same light, and even Tournefort, who published his Botanical Institutions about the beginning of the eighteenth century, when the doctrines alluded to had begun to be more than suspected, and the doctrine of vegetable sexes admitted, at least in part, classes these mosses along with mushrooms and sea weed, under the title of *asperme*, or plants without seed. But this arrangement was not long held as at all satisfactory; and botanists, who began to suspect that a distinction existed even in mosses, were at last induced to undertake the irksome, but indispensable task of a minute and scrupulous investigation of the several parts and appearances of individual subjects, during the several stages of growth, with a view to the discovery of sexual organs. Perhaps the first hint leading to a correct view of the subject, was that given by Dillenius in his appendix to his Catalogue of Plants growing in the neighbourhood of Gisse, in which he regards the mosses as being indeed without seed, but furnished with little heads containing a powder, by which the terminating leaves were rendered capable of germination. But Micheli, inspector of the botanic garden at Florence, seems to have been the first of all modern botanists who obtained a complete view of the fructification of the mosses as consisting of a sexual apparatus, which he not only describes but figures, though he appears to have been at the same time wholly ignorant of the respective functions of the organs he was describing, having mistaken the barren for the fertile flower, and being, perhaps, altogether unacquainted with the true and legitimate doctrine of the sexes of plants. Dillenius, who again resumed the subject in his "History of Mosses," (Oxford, 1741,) a work that still stands unrivalled in this most difficult department of vegetable research, though he describes the flowers of the mosses with great accuracy, and also with a view to sex, discriminating the barren from the fertile flower, as being sometimes produced on the same, and sometimes on a different plant; yet, he still unhappily mistakes the former for the latter, and by consequence the latter for the former, without having thrown any new light on this most important part of the history of mosses, for which he was indeed so peculiarly well qualified. Linnæus, whose original ideas on the fructification of the mosses seem to have been correct, by adopting as the ultimate result of his investigations the opinions, and consequently the errors of Dillenius, left the subject involved in the same obscurity in which he found it; and by giving to error the sanction of his great name and authority, became unfortunately the occasion of misleading future inquirers, rather than of conducting them to the truth. The elucidation of this obscure subject was afterwards undertaken by several contemporary or succeeding botanists, without much success, particularly by Hill in his History of Plants, in which he controverts the opinions of Dillenius and Linnæus on the subject of the fructification of the mosses, and shows them to be erroneous, proving the capsula of the former, and the anthera of the latter, both terms indicating the same idea to be a real seed vessel, by means of the experiment of sowing the powdery substance contained in it, and obtaining, as the result, a crop of young mosses. This was of course an unanswerable argument, and a discovery of the utmost importance; and yet the work of Hill is now among botanists seldom heard of. But by thus disproving the opinion of Linnæus with regard to the anthers of the mosses, he was now under the necessity of looking out for the true anthers in some other part of the flower or plant, which he at last discovered, as he thought, in the same flower, and in what he called the rays of the corona. But this opinion was soon found to be equally erroneous with that which he had just refuted, because it supposed the flowers of all mosses to be hermaphrodite, which they in fact are not; and because the flowers of many of these are destitute of a corona altogether. Some other opinions were afterwards advanced by several botanists hostile to the former, and at variance with each other, and tending only to show that the most profound mystery still enveloped the subject; or, to introduce a degree of botanical

scepticism, inconsistent with impartial research, which discovered itself even in the celebrated Necker, urging him to exclaim rather too rashly, that whatever had been or might in future be said of the fructification of the mosses, he was determined to regard as a fiction or a dream. In this stage of progress, the celebrated Hedwig first began to direct his attention to the study of the mosses, when, perceiving all that had been previously done, with a view to elucidate their fructification, to present but a chaos of confusion and contradiction, he found it absolutely necessary to renounce all sort of dependence upon previous opinion and authority, and to examine every thing for himself. This he accordingly did with a degree of caution, and scrupulosity, and patience never yet surpassed; so that, by applying glasses of a higher magnifying power than any preceding botanist, and taking no fact upon trust, he at length succeeded in obtaining a clear and complete view of the subject, in disencumbering it of the rubbish with which it had been so long clogged, and in presenting to the cryptogamist a superstructure not the offspring of his own fancy, but the image of nature. According to Hedwig, the mosses are, for the most part, *diœcious*, that is, they have the barren and fertile flowers on separate plants, as in the family *hypnum*. Many of them are, however, *monœcious*, or have the barren and fertile flowers distinct, but placed on the same plant, as in the family *phascum*; a few of these are *hermaphrodite*, or have the two kinds of flowers united on the same plant, as in the *bryum aureum*.

We shall now attempt a description of the two kinds of flowers. The barren flowers are a sort of disks or buds, which frequently terminate the branches of the mosses, or sit in the bosom of the leaves. If they are carefully dissected under a good magnifier, they will be found to consist of an assemblage of leaves or scales, resembling the other leaves of the plant in form; but generally larger or more elegant, and sometimes also coloured, though never terminating in a hair. These Hedwig regards, though upon grounds somewhat questionable, as constituting the calyx of the barren flower. If the leaves of this calyx are now taken and carefully stript off in succession, the dissector will find, as he approaches the centre, a number of small thread-shaped and succulent substances, closely crowded together, and issuing from between the leaves, or if not so issuing, occupying the centre of the disk, and distinguishable into two different sorts; some consisting of an individual and transparent viscus, and others of a longitudinal succession of small and transparent vesicles united at the extremities, so as to exhibit a sort of jointed or necklace appearance. Both of these may be readily detected in the barren flowers of *polytrichum commune*, if gathered in the month of May or June. The former Hedwig regards as stamens, distinguishable into filament and anther, or the anther longer and somewhat cylindrical; but generally approaching more or less to club or egg-shaped, and both not exceeding the one fiftieth part of an inch in length. The latter or necklace-looking substances, which are generally somewhat longer than the stamens, though less in diameter, do not yet seem to be well understood. Hedwig, without pretending absolutely to decide upon their use, calls them merely the succulent threads that accompany the stamens; but seems, at the same time, to believe that they assist fecundation by means of securing a plentiful supply of moisture, while he infers the stamens to be such, from the presumptive evidence of the similarity of their substance and structure, to that of the stamens of perfect plants; and of their opening also at the top when ripe, and discharging a fine pollen, which circumstance may be seen by means of placing a stamen fully ripe under a high magnifier, and wetting it with a drop of water. The summit of the anther bursts open, and the pollen explodes.

The fertile flowers are like the barren, generally at the extremities of the branches, but they are not unfrequently lateral or radical. They are not furnished with any integument that can be decidedly called a calyx, though the leaves immediately surrounding these are generally different both in size and structure, from the other leaves of the plant; and in the genus *hypnum* are so very obviously different, as to have obtained the proper appellation of the perichælium or fence, being an assemblage of loosely imbricated scales, terminating in a fine hair or bristle, rather than red leaves. But if they are not to be regarded as forming a true calyx, or part of the real leaves of the species, they are at least to be regarded as constituting floral leaves, both from their contiguity to the flower and analogy to the floral leaves and perfect plants. In their original distribution they form generally a sort of bud, from the centre of which the flower issues, presenting, when first discoverable, the appearance of a fine and minute point, projecting from the bosom of the leaves. This incipient step of growth is very distinctly visible in the fertile flowers of *fumaria hygrometrica*, *a*, if gathered about the month of January, which are also accompanied by a number of succulent pistils, somewhat similar to those already described as accompanying the barren flower, and equally unaccountable. Hedwig calls them

56.



auxiliary pistils, but does not pretend absolutely to determine their function, and Sir J. E. Smith thinks they may perhaps serve in either case the purpose of calyx or of corolla, or of both. But however this may be, the parts of the flower soon begin to assume a different appearance as the process of fructification advances, the fine and pointed substances expanding into a sort of lengthened cone, invested by a thin and membraneous integument, which is adherent at the base and summit, but inflated towards the middle, and which finally separates horizontally into two distinct portions. The under portion, which is placed within the fence, remains, as before, attached to the base of the fructification, and is called the sheath, while the upper portion adheres also, as before, to the summit of fructification, which it still partially invests in the form of an extinguisher. In this stage it has been called by some a calyx, by others a corolla. But its resemblance to either is so extremely slight, as scarcely to justify the application of the term. It is more generally known, however, by the appellation of the calyptra or veil, a term sufficiently expressive of at least part of its functions, marking, as it does, a globular or urn-shaped vessel, which is the capsule of the mosses. In some species, this capsule is sessile, or very nearly so, as in *phascum muticum*, but in by far the greatest number it is elevated upon a fine and often capillary, but conspicuous pedicle, as in *polytrichum commune;* sometimes it is erect, and sometimes drooping, nodding, or pendulous. The external surface is generally smooth, but sometimes it is marked with longitudinal furrows, being, when in a young state, somewhat white or green, but when in a mature state, brown red or yellow. Like the capsules which they support, the pedicles are sometimes erect, as in *Bryum cylindricum*, and sometimes bent, as in *Bryum hornum.* They are generally solitary, but sometimes also aggregate, as in *Bryum ligulatum*, in which it is no unusual thing to find five or six of them issuing from the same point. In some species, they are so very short, as to be scarcely perceptible, and in others they are from one to three inches in length. The surface is generally smooth and shining, though sometimes it is rough. Its colour is sometimes white and pellucid, while in a ripened state it becomes brown, yellow, purple, or red. At the base it is almost always sheathed by a thin and membraneous substance, the lower portion of the original veil, and sometimes it is slightly bulbous. At the summit it is also often distended into a larger bunch or protuberance, of a globular or oval form, upon which the capsule sits, as in the genus *splachnum*, which protuberance is denominated the *apophysis.* The mouth of the capsule is externally covered with an operculum or lid, assuming, in different species a variety of different forms, and detaching itself horizontally when ripe. Sometimes it is flat, hemispherical, generally conical or acute. In its position it is erect, or oblique, or bent, or crooked; on its surface it is smooth, or straited; in its colour brown, red, or scarlet, when ripe. If this bud is stripped off, or detaches itself spontaneously, the mouth of the capsule is then found for the most part to be internally furnished with one or more rows of fine teeth, in number four, or a multiple of four, named the *peristome*, sometimes united into one set, and sometimes divided into several. In some families, however, it consists of a single row of teeth only, and in others it is altogether wanting, as in the *sphagnum.* The number of the teeth is also variable in different genera, though generally uniform in the same. In their ripened state, they assume a tinge of brown, red, or yellow, as does also the lip of the urn or capsule in which they are inserted. Within the urn, and in the direction of its longitudinal axis, there is situated a slender and cylindrical substance, as seen figure *b*, which seems to be a prolongation of the pedicle passing through the whole extent of the urn, and perforating both bud and veil. This organ is designated by the name of the column, and its summit, which forms the apex of the flower, is regarded by Hedwig as the style of the mosses. As the urn and column are concentric, there is formed by consequence, between the inner surface of the one, and the outer surface of the others, a small and cylindrical cavity, which in the mature state of the fructification is filled with a fine powder, consisting of a multitude of spherical granules, of a brown, yellow, or greenish colour, generally smooth, but sometimes also dotted or prickly. These granules are the seeds of the mosses, from the sowing of which Hedwig obtained a crop of young mosses, in all respect similar to the parent plants. Such is a short sketch of the fructification of the mosses, according to the observations of Hedwig, and of the theory founded upon them, namely, that the mosses are, with very few exceptions, either *monœcious* or *diœcious* plants, furnished with all organs essential to the constitution of a flower, and producing perfect seed; a theory that seems at least founded on fact, and that has obtained the approbation of many succeeding botanists. Others, again, deny all the cryptogamic class the organs of fructification properly so called. Thus Richard remarks:—

"We agree with Necker in considering the plants designated by the name of *cryptogamus* as entirely destitute of sexual organs, and are of opinion that nothing in them can reasonably be compared to these parts as they exist in phanerogamous plants."

A reproductive corpuscle of a fern or a mush-

room, if placed on the ground, will be developed there; but it will not be, as in the embryo of a phanerogamous plant, parts already formed, only reduced as it were to their rudimentary state, that will successively acquire a greater development; but, on the contrary, parts entirely new will be produced. It is not a growth of organs already existing; but the tissue of the *sporule* or reproductive corpuscle, becomes elongated, on the one hand to sink into the ground and form a root, when the vegetable is to have one, and on the other hand to stretch up in the opposite direction and form a stem. In whatever position a sporule may be placed, the part in contact with the earth always elongates to form the root, and the opposite part becomes the stem. These two organs, therefore, do not exist previous to this development, but are produced by the influence of certain circumstances, which appear as if fortuitous and foreign to the very nature of the body which produces them.

If we now examine the parts which have been looked upon as the flowers by various authors, we shall find that their opinions respecting them are very discordant; some considering as male flowers what others describe as female flowers. Thus, in the mosses, Linnæus considers the theca as a male flower, Hedwig as a female flower, and Palisot de Beauvois as a hermaphrodite flower.

Whenever these plants, as, for example, the mosses, present two very distinct kinds of particular organs, which have been considered as those of fructification, authors could only have been embarrassed in selecting this or that for the function which they had to attribute to it. But, in the Jungermanniæ, where there are sometimes three or four kinds of fructifications differing from each other in their external form, as there are only two kinds of sexual organs, the male and the female, it would be necessary here to admit four. For, if the name of sexual organs has been given to two of these parts, why should it be denied to the other two, whose internal structure is the same, but which differ only in their external forms, or in their disposition?

In the ferns, on the contrary, in which there is evidently but a single species of fructification entirely formed of small grains, commonly enclosed in little membranous bags, and which have been considered as seminules or seedlets, where are the stamina? Where the stigma which has received the influence of the pollen? Where the pistil which has transmitted it to the ovules? Does it afford a satisfactory answer to these questions to say, as Micheli and Hedwig have done, that the hairs which are observed on the young leaves are the stamina; or, as Hill and Schmidel have asserted, that the male flowers are the rings which surround the receptacles in which the seminules are contained?

It must be admitted that opinions so discordant, and even contradictory, lead us to an inference which appears to be inevitable, and which is, that the alleged flowers of agamous plants, sometimes considered as containing stamina, and sometimes as containing pistils, are not in reality flowers, but peculiar organs, constituting a kind of buds, to which nature has intrusted the reproduction of these singular plants. Why, in fact, should we wish to confine the power of nature within the narrow limits of our conceptions? Her means are as varied as her power is great; and if she has bestowed upon the agamous plants an aspect so different from that of the phanerogamous, and given them external organs which often bear no resemblance to those of the latter, why might she not also have accorded them a peculiar mode of reproduction, having nothing similar to that of phanerogamous plants but the effects which it produces, in other words, the formation of the organs by which the species is to be perpetuated?

Hepaticæ. The reproductive organs of this class of simple vegetable productions, in as far as they are yet known, are pretty much analogous to those of the mosses; but the parts corresponding to the stamens and pistils of perfect plants, do not appear to have been hitherto ascertained so satisfactorily as to leave no ground of doubt. In their flowering, however, they appear also, like the mosses, to be either monœcious or diœcious, and, perhaps, even without exception so, the example of an hermaphrodite flower being almost unknown. According to Hedwig, the barren flower of the hepatica which can scarcely be said to have any perceptible calyx, or corolla, consists either of small and globular protuberances, issuing from the summit of the plant, or from among the leaflets, or from the surface of the frond, constituting a viscus that contains a powdery substance, which is the pollen, as in *Jungermania;* or of small and minute granules, surrounded with substances resembling the succulent threads of the mosses and imbedded in the body of the frond, or in target-shaped substances issuing from the surface of the frond, and elevated in conspicuous pedicles. The fertile flowers consist for the most part of a double envelope, an outer and an inner, the former corresponding in some degree to the calyx, and the other, which immediately invests the ovary, and is surmounted with the style, to the corolla of perfect plants. The ovary, which in some species remains sessile, and in others is elevated as a pedicle, opens, when ripe, into several longitudinal valves, and discharges the seed. If a plant of jungermania is examined, even by the naked eye, in an early stage of its growth, there will be seen, besides the general herbage, a number of small oblong and sack-like substances, issuing from among the leaflets, and assuming

a position perpendicular to the surface of the frond. These sacks, which are the outer envelopes of the flower, if carefully opened up, will be found to contain an oblong or egg-shaped substance, which is the ovary wrapped up in a second envelope that is perforated by the style. If this second envelope is more carefully stripped off, the ovary and style will appear, accompanied with several succulent substances, resembling the abortive pistils of the mosses; and if the ovary is itself opened up, it will be found to consist of a greenish and gelatinous mass, interspersed with a multitude of minute granules. If the flower, instead of being thus dissected, is allowed to ripen in the plant, the envelopes will, in the progress of fructification, burst open at the top, and discover a small protruding globule, of a black or brownish colour, and of about the size of a millet, and which is by and by disengaged entirely from them, and elevated on a fine and thread-shaped pedicle, from a line to an inch or more in length. This elevated globule is the ovary, which, when ripe, separates into four longitudinal valves; from the extremities of which a number of small spiral and elastic threads issue, to which the seeds are attached. The hepaticæ, like the mosses, are capable of being propagated by the sowing of their seeds. But it has been observed, by Hedwig and others, that the hepaticæ produce also gems as well as seed, by which the species are often propagated. If a plant is carefully inspected, there will occasionally be observed a number of small cup-shaped substances immersed in the frond, and toothed at the border. The cups are filled with a number of small granules which are the gems.

Algæ. The fructification of the algæ is less perfectly known than that of any of the preceding tribes of simple plants; but it has received, like them also, considerable elucidation from the investigations of Hedwig, particularly the *lichens.* In all species of lichens, a plant found abundantly on rocks and stones, and consisting merely of a frondose form, without stem or root, there issues from the edge or surface of the frond, a number of small tubercles, or wart-like substances of the colour and texture of the parent lichens. If one of these is taken in an early state of its growth, and divided by means of a verticle section, it will be found to consist of a single or double cell, imbedded in the pulp of the frond, and containing a granulated mass. The contained granules are particles of pollen, the maturity of which is indicated by the changing of the colour of the tubercle to a deep brown, and their escape by its changing to black. From a different part of the same plant, or from a different plant of the same species, there are also found to issue a number of cup-shaped or target-shaped substances, supported on short pedicles of the same contexture with the frond, and of a greenish colour, but gradually becoming dark as they ripen. If one of them be now divided, by means of a verticle section, it will be found to contain immediately under the black crust at the top, a number of small and egg-shaped substances, arranged in perpendicular columns. These substances are the seeds, which finally escape through the crust. In this species, both the barren and fertile flowers are well shown in *lichen physodes.* Such is the theory of Hedwig, but Gærtner, who is also a great authority on this subject, contends that the powdery substance ejected from the targets or saucers, consists not of seeds, but of a peculiar species of gem, which he denominates the *propage,* and describes as being a simple gem, without leaves or regular shape; sometimes naked, and sometimes covered with an envelope, which separating at length from the parent plant, is dispersed in the way of seeds, but is not itself a seed. In the remaining genera of the algæ, the fructification is, if possible, still more obscure, exhibiting no traces of stamens or pistils, or even of the warts and saucers of the lichens, but merely a number of small granules, irregularly dispersed throughout the substance of the plant, and extricated only by its decay, which Hedwig presumes to be seeds, but which Gærtner regards also as a peculiar species of gem, which he calls *gongylus,* describing it as being a simple gem without leaves, of a globular form and solid contexture, embedded in the bark of the plant, and extracted only by its decay; so that it may very well be doubted whether the genera in question do at all produce perfect seeds, or are propagated by any other means than that of gems. In the *fuci,* the interspersed granules are said to have a perforation above them, which the other families have not.

Fungi. Micheli seems to have been the first to detect what may be regarded as the seeds of the fungi; but Hedwig expected to find, and tried also to discover in them, as indeed in all cryptogamous plants, the same sort of reproductive organs as are found in plants with conspicuous flowers. And from a persuasion that they existed, and were certainly to be detected, he was in some cases, perhaps, rather too soon satisfied of having succeeded in their detection. In fungi furnished with gills * and a curtain, if the inner surface of the curtain is carefully examined with a good magnifier before the time of its natural detachment from the *stipe* or *pileus,* there will be found adhering to it a number of fine and delicate threads, supporting small globules, and in such as have no curtain, the same sort of substance may be found adhering to the edge of the pileus. These Hedwig regards as stamens.

* See fig. 22, page 19, where *b* points out the gills it the mushroom.

If the gills are next examined in the same manner, and about the same time, there will be found resting on their edges or surface a number of small tender cylindrical substances, some of which are surmounted by a small globule, while others are without this. These he conjectures to be the styles and summits. Similar substances may be detected on the other families of the same tribe; but from the extreme minuteness of these parts, and from their strong likeness to the down with which the inner organs of vegetables are covered, it is easy to perceive how very difficult it must be to decide upon their true character. Bulliard does not pretend to have discovered, and does not think it necessary that there should exist in the fungi, organs exactly corresponding to the stamens and pistils of conspicuous flowers, but only organs analogous to them, and capable of performing similar functions, the ground of which opinions he has illustrated in his theory of the fructification of the fungi, and rendered at least as tenable as any that have been taken up against him. Gærtner is also of opinion that the fungi do not in any case produce perfect seeds, but are propagated like fuci, by that peculiar species of gem which we have already alluded to. However this may be, one thing is certain, that the fungi as well as the other simpler plants, do propagate their species by gems or seeds. In the agaricus and other similar mushrooms, this receptacle is the gills, in which, by the aid of a good microscope, about the time the curtain bursts, there may be observed, on raising up a small portion of their flat surface, a number of small minute granules imbedded in their substance; these granules are the seeds or gems, which, in a ripened state, are discharged in such numbers and with such force, that a piece of white paper put under the plant will soon be found covered with a fine brown powder. In the *boletus* this receptacle is the tubes. In the *moulds* it is the globule, surmounting the thread-shaped pedicle or stipe; in the *clavaria* it is over the general surface.

CHAP XV.

OF FECUNDATION.

The discovery of the male and female organs in plants opened a new field of observation, by directing attention to the mode of action which they exercise upon each other.

Until of late years, the *mechanism* of fecundation in plants was as little understood as that of animals. It was known, however, that the female organ is fecundated; that the ovules or rudiments of the seeds contained in the ovary become fit for being developed, and for subsequently reproducing precisely similar individuals, whenever the pollen, contained in the cells of the stamen, has exercised its influence upon the stigma. But the nature of the influence which the pollen exercises upon the stigma was entirely unknown. The recent inquiries of various observers, have thrown much light on this important question, and have shown that, in plants, fecundation appears to have the same mechanism as in animals.

Here, as in her other works, we find occasion to admire the wisdom of Nature, and the perfection which she gives to the instruments which she employs. Animals, possessed of the faculty of moving, and able to shift at will from one place to another, generally have the organs of generation separated on two individuals of the same species. The male, at determinate periods, excited by an internal feeling, seeks out and approaches the female. Plants, on the other hand, destitute of the locomotive faculty, irrevocably fixed to the place in which their existence has commenced, and destined to grow and die in it, generally have the two sexes combined, not only in the same individual, but in most cases even in the same flower. Thus hermaphrodism is very common in plants.

There are some, however, which might at first sight seem less favourably situated, and in which fecundation might appear to be left by nature to chance, such as the monœcious and diœcious plants. In them the two sexual organs are separated from each other, and often removed to great distances. But here also we find reason to admire the wisdom of Nature. As in animals the fecundating substance is fluid, the male organ must in them act directly upon the female organ before fecundation can be effected. If it had been of the same nature in plants as in animals, fecundation would doubtless have experienced the greatest obstacles in the monœcious and diœcious species. But in vegetables the pollen exists in the form of a powder, whose particles are light and extremely minute, so that they can be transported in the atmosphere to distances which are often inconceivable.

It may also be remarked that, in monœcious plants, the male flowers are generally situated at the upper part of the plant, so that the pollen, on escaping from the cells of the anther, falls naturally, and by its own weight, upon the female flowers, which are placed lower.

Hermaphrodite flowers are unquestionably those in which all the circumstances are most favourable to fecundation, the two sexual organs being in them placed in the same flower. The function commences the moment the cells of the anther open to allow the pollen to escape. There are plants in which the adherency of the anthers permits fecundation to take place before

the perfect expansion of the flower; but, in the greatest number of vegetables, this phenomenon does not happen until after the floral envelopes have opened and spread out. In certain hermaphrodite flowers, the length or shortness of the stamina, compared with the pistil, might at first seem to present an obstacle to fecundation; but, as already remarked, when the stamina are longer than the pistil, the flowers are generally erect, whereas in those which have the stamina shorter than the pistil, they are reversed. We need not point out how much this arrangement must facilitate the act of fecundation. When the stamina are as long as the pistils, the flowers are either erect or pendulous.

To favour the emission of the pollen, and place it in contact with the stigma, the sexual organs of many plants perform very sensible motions. Thus, to recur to examples already alluded to, at the period of fecundation, the eight or ten stamina which compose the flowers of the rue rise successively towards the stigma, deposit part of their pollen upon it, and then fall outwards.

The stamina of *sparmannia Africana* and the barberry when irritated with the point of a needle, contract and approach each other.

In several genera of the family of Urticeæ, in the pellitory and the paper mulberry, the stamina are bent towards the centre of the flower, and beneath the stigma. At a certain period, they rise elastically, like so many springs, and cast their pollen upon the female organ.

In the genus *Kalmia*, the ten stamina are placed horizontally at the bottom of the flower, and their anthers are enclosed in an equal number of small pits, which are perceived at the base of the corolla. To produce fecundation, each of the stamina bends a little upon itself, in order to disengage its anther from the little cavity which contains it. It then rises above the pistil, and pours its pollen upon it.

The female organs of certain plants appear in like manner to perform motions which depend upon their greater irritability during the period of fecundation. Thus the stigma of the tulip, and several other liliaceæ, swells and appears moister at that time. The two laminæ which form the stigma of the mimulus come together whenever a little mass of pollen, or a foreign body of any kind, happens to touch them. It even appears, according to the observations of Lamarck and Bory St Vincent, that some plants develope a very sensible heat at this period. Thus, in *arum Italicum*, and some other plants of the same family, the spadix which supports the flowers disengages a quantity of heat sufficient to be felt by the hand that touches it.

Many aquatic plants have their flower buds at first under water. They are seen gradually to approach the surface, emerge, and expand, to descend again after fecundation has taken place, and ripen their seeds under the water.

Fecundation may be effected, however, in plants that are entirely submersed. Thus, Ramond found, in the bottom of a lake among the Pyrenees, the *ranunculus aquatilis* covered with water to the height of several feet, and yet bearing flowers and perfectly ripe fruits. Fecundation had therefore been effected in the midst of the liquid. M. Batard afterwards found the same plant in similar circumstances. He made the curious remark that each flower, thus submersed, contained a quantity of air within its membranes, previous to its expansion, and that fecundation was effected through the medium of that fluid. The air which he thus found enclosed in the floral envelopes was evidently derived from vegetable expiration.

This observation, the accuracy of which has since been repeatedly verified, explains perfectly the mode in which submersed plants are fecundated, when they are furnished with floral envelopes; but it is totally inapplicable to vegetables destitute of the calyx and corolla, the fecundation of which is effected, although their flowers are entirely submersed.

But admitting that the pollen is conveyed to the stigma by the means above stated, how is it thence conducted to the ovary? It was at one time generally supposed that the pollen is conducted from the stigma to the ovary by means of a longitudinal canal perforating the style. This canal is distinguishable in many of the liliaceous plants, in which it seems indeed to constitute the passage of the pollen, particularly from the phenomenon of the *amaryllis formosissima*, the fluid exuding from the stigma of which returns again through the perforation of the style tinged with yellow, the colour of the pollen. But the existence of the canal in question, though distinguishable in the *amaryllis formosissima*, and other liliaceous plants, cannot be admitted as a universal property of the style, at least it cannot be detected. And if it is so very fine as to escape all observation, then it could not admit the particles of pollen, which are in some cases comparatively large, as in marvel of Peru; the pollen of which exceeds the style itself in diameter, and could not consequently be admitted by a central canal.

But in order to effect the impregnation of the seed it is not necessary that the particles of pollen should enter the style entire. The finer part of their contents is sufficient, and is indeed the only effective part in the act of fecundation: so that whether we regard it as a subtle and elastic vapour with Grew and Adanson; or merely as an oily and gelatinous fluid exuding or exploding from the globule; still it will admit of being conducted through the channel of

the tubes of the style, although no central canal should exist in it.

But another question has also arisen out of the subject with regard to the quantity of pollen necessary to effect impregnation. Adanson was of opinion that the smallest possible particle, if conveyed to the ovary, is sufficient. But this opinion is supported by no proof, and is even contradicted by later observation; the merit of having ascertained the fact seems due to Koëlreuter, whose experiments are decisive of the question. The globules of pollen contained in all the anthers of an individual flower of *hibiscus syriacus*, were 4863, of which fifty or sixty at least were necessary to effect a complete impregnation. For when the attempt was made with a smaller number, the seeds were not all ripened, though those that were ripened were perfect. Ten globules were the least by which the impregnation even of a single seed could be effected in this plant. But in the *mirabilis jalappa* and *longiflora*, the flowers of which contained about 300 globules of pollen, two or three were found sufficient for impregnation, as the seed was not improved by the application of more. It was also found that the impregnation of flowers having two or more styles, was completely effected, even when the pollen was applied but to one of them; which shows that there is a communication between all the styles, and consequently between all the germens.

Admitting that the pollen is conducted to the ovary through the channel of the tubes of the style, how after all is the ovary fecundated; or the seed rendered fertile? On this subject naturalists have been much divided; and according to their several opinions they have been classed under the respective appellations of ovarists, animalculists, and epigenisists.

Theory of the ovarist. According to the opinion of the first class, the embryo pre-exists in the ovary, and is fecundated by the agency of the pollen as transmitted to it through the style. This seems to have been the opinion of Grew, who says expressly in his Anatomy of Plants, that when the summits of the stamens open, and the pollen is discharged upon the pistil, some subtil and vivifying effluvium escapes; which, descending through the medium of the style, impregnates the embryo. Bonnet and Haller seem to have been of the same opinion also, as well as many other eminent naturalists. But the most convincing evidence in support of the opinion of the ovarists is that which has been produced by Spallanzani, as founded on a series of observations on the flowers of the *spartium junceum*. This plant was chosen on account of its producing at the same time flowers in all the different stages of progress. His first observations were made upon flower buds not yet expanded: they seemed to form a compact and solid body; but upon being dexterously opened, the petals, which were yet green, were with some difficulty discovered, then the stamens, and then the pistil. The powder of the anthers was even perceived imbedded in a glutinous substance; when the pistil was freed from the surrounding integuments, and attentively viewed with a good glass, the pod was also discovered of about $1\frac{1}{10}$ line in length. Several protuberances were seen upon its sides; which, upon opening it longitudinally, were found to be occasioned by the seeds, which though but small globules, were already discoverable, arranged in their natural order, and attached by filaments to the interior of the pod. Upon dissection, they did not exhibit any appearance of the several parts and membranes into which the mature seed may be divided; but a spongy, homogeneous mass. Flowers in the same state of forwardness were not fully expanded till twenty days after. On dissecting buds of a larger size the petals were found to be somewhat yellowish and less compact; and the powder of the anthers was thrown out by the slightest agitation; but the lobes and plantlet were not yet perceptible in the seeds.

On the eleventh day after the flowers had fallen, that is, after impregnation had taken place, the seeds, which were formerly globular, began to assume the figure of an heart, attached to the pod by the basis, and exhibiting the appearance of a white point towards the apex. And when the heart was cut open longitudinally, the white point proved to be a small cavity enclosing a drop of liquid.

On the twenty-fifth day after the flowers had fallen, the cavity was much enlarged towards the base; but was still full of the liquid, in the midst of which there appeared a small and semi-transparent body, of a yellowish colour and gelatinous consistence, fixed by its two extremities to the opposite sides of the cavity. In a month after the flower had fallen, the heart-shaped seeds became kidney-shaped. In forty days after the flower had fallen, the cavity was quite filled up with the body that had been generated within it; and which was now found to consist of a thin and tender membrane enveloping the two seed-lobes, between which the plantlet attached to the lower extremity was also perceptible. And hence the seed was now visibly complete in all its parts.

From these and a variety of other observations on a number of other species, all of which exhibited similar appearances in the generation of the seed, Spallanzani concludes that the seeds pre-exist in the ovary before the access of the pollen, by which they are merely rendered fertile; and contends that the embryo, though not previously perceptible, may yet previously exist.

The theory of the ovarists is supported also by Gærtner, who describes the vegetable egg as

pre-existing in the ovary, where, furnished with its proper integuments, it waits the fecundating influence of the pollen, which is necessary to its complete development; so that it requires in fact the exertion of two distinct energies to bring it to perfection, the vital principle, and the seminal; the former generating and organizing the different parts of which the egg consists in common with the other parts of the plant; and the latter communicating to the egg thus formed a distinct vegetable life.

Theory of the animalcules. But the theory of the ovarists is not without its difficulties; for as the embryo is never found to make its appearance till after fecundation, it has been thought that it must necessarily pre-exist in the pollen of the anther; from which it is conveyed to the ovary through the medium of the style, and afterwards matured. This theory was founded upon that of Leuwenhoeck, with regard to animal generation; which supposes the pre-existence of animalcules in the seminal principle of the male; the animalcules being conveyed *in coitu* to the ovary of the female, where alone they are capable of development.* Hence it has been denominated the theory of the animalculists, and transferred to the case of vegetables by Morland, Needham, Gleichen, and others, who regard the pollen as being a congeries of seminal plants, one of which at least must be conveyed to the ovary entire before it can become prolific.

But if the embryo pre-exists in the pollen, may it not be detected by inspection before impregnation takes place? Spallanzani examined the pollen in its ripe and perfect state with great care, and under glasses of the highest magnifying powers, but could distinguish nothing exhibiting the appearance of an embryo. It may be said, however, that the embryo must still be supposed to pre-exist in the pollen, though not visible, as Spallanzani has said of its pre-existence in the ovary; and that its invisibility is no proof of its non-existence. The animalculists have no doubt a right to offer this reply; but as the embryo is not visible whether in the ovary or pollen, till after fecundation has taken place, no conclusion can be drawn on either side from the circumstance of its invisibility.

But admitting that the invisibility of the embryo is no proof of its non-existence in the pollen, the total want of a passage, in most styles, fit to conduct the particles of pollen entire, exposes this theory to the most serious objections, if it does not rather render the alleged mode of impregnation altogether impracticable. And if a passage of sufficient width were found to exist even in all styles, still the probabilities of the two cases are in favour of the ovarist. For if the embryo is to pre-exist at all, is it not more likely that it should pre-exist in the ovary, where it is to be brought to maturity, than that it should first be generated in one organ or plant, and then transferred to another to be developed? Is it not also most extraordinary that the embryo should so invariably assume the same position in the same species of seed, if it is merely conducted to the ovary from a different organ or plant, and introduced as it were at random? And is not the doctrine of the ovarist countenanced from the analogy of the process for which he contends to that of the generation of the animal egg, which is produced complete in all its integral and distinct parts even without the cooperation of the male, though still destitute of the principle of fertility? And finally, is it not further countenanced from the fact of the apparent and numerical perfection of parts often observable in the fruit of insulated female plants, in which the embryo is not always wanting, but only not fecundated? For which reasons the theory of the ovarist seems to be much more consonant to truth than that of the animalculist.

Theory of the Epigenisists. But the difficulties inseparable from both theories, together with the phenomenon of hybrid productions, have given rise also to a third; this is the theory of the epigenisists, who maintain that the embryo pre-exists neither in the ovary nor pollen, but is generated by the union of the fecundating principles of the male and female organs; the former being the fluid issuing from the pollen when it explodes; and the latter, the fluid that exudes from the surface of the stigma when mature. As applicable to the case of plants, this theory has been stoutly defended by Koëlreuter, who adduces in support of it a variety of experiments instituted with a view to ascertain the fact by means of impregnating the ovary of one species with pollen taken from another, in which cases the plant obtained from the seed uniformly exhibited a combination of the characters of both species. The following is a most prominent example, being the result of his experiments on *nicotiana rustica* and *paniculata;* the former having egg-shaped leaves, with a short and yellow corolla approaching to green; and the latter having roundish or cordated leaves, with a green corolla approaching to yellow, and a stem longer by one half. A flower of the former species was accordingly deprived of all its stamens, and fecundated with pollen from a plant of the same species. The plant raised from the seed thus obtained was an hybrid, exhibiting in all its parts an intermediate character betwixt the two species from which it sprang. The stamens of this hybrid, as well as of all others he ever raised, were imperfect; but when its pistils were impregnated with pollen from the *paniculata* as before, the new hybrid obtained

* Phil. Trans. No. 145, p. 74.

from the seeds now produced was more like a *paniculata* than formerly; and when the experiment was continued through several successive generations, it was at last converted into a perfect *paniculata*.*

This is thought to be an infallible demonstration of the truth of the doctrine of the epigenisists. But why may not the pollen of one species of plant be allowed to produce some particular change upon the development of the embryo of another species, although that embryo should be supposed to have pre-existed in the ovary? The action of the pollen thus introduced must amount to something; and it is just as difficult to conceive how an individual, whether proper or hybrid, should be generated from the union of the seminal principles of two plants of the same or of a different species, as from the peculiar effect of the pollen of the same, or of a different species, upon an embryo already existing. But the doctrine is yet liable to a much more serious objection; for if the seed is generated from the union of two fecundating principles which form an intermediate offspring, then female plants of the class *diœcia* ought occasionally to produce seeds whose offspring shall be *hermaphrodite*, or at least *monœcious*, which was never yet known to happen.

Although the arguments of the epigenisists are by no means satisfactory, yet it cannot be denied that hybrid productions partake of the properties both of the male and female from which they spring. This was long ago proved to be the fact by Bradley, and more recently confirmed by the experiments of Mr Knight; as well as happily converted to the advantage of the cultivator. Observing that farmers who rear cattle improve the progeny by means of crossing the breed, he presumed from analogy that the same improvement might be introduced into vegetables. His principal object was that of procuring new and improved varieties of the apple and pear, to supply the place of such as had become diseased and unproductive, by being cultivated beyond the period which nature seems to have assigned to their perfection. But as the necessary slowness of all experiments of the kind, with regard to the fruit in question, did not keep pace with the ardour of his desire to obtain information on the subject, he was induced to institute some tentative experiments upon the common pea, a plant well suited to his purpose, both from its quickness of growth, and from the many varieties in form, size, and colour, which it afforded. In 1787, a degenerate sort of pea was growing in his garden which had not recovered its former vigour even when removed to a better soil. Being thus a good subject of experiment, the male organs of a dozen of its immature blossoms were destroyed, and the female organs left entire. When the blossoms had attained their mature state, the pollen of a very large and luxuriant gray pea was introduced into the one half of them, but not into the other. The pods of both grew equally; but the seeds of the half that were unimpregnated withered away, without having augmented beyond the size to which they had attained before the blossoms expanded. The seeds of the other half were augmented and matured as in the ordinary process of impregnation; and exhibited no perceptible difference from those of other plants of the same variety, perhaps, because the external covering of the seed was furnished entirely by the female. But when they were made to vegetate in the succeeding spring, the effect of the experiment was obvious. The plants rose with great luxuriance, indicating in their stem, leaves, and fruit, the influence of this artificial impregnation; the seeds produced were of a dark gray. By impregnating the flowers of this variety with the pollen of others, the colour was again changed, and new varieties obtained superior in every respect to the original on which the experiment was first made, and attaining, in some cases, to a height of more than twelve feet. In these experiments it was observed that the plant had a stronger tendency to produce coloured blossoms and seeds than white ones. For when the pollen of a coloured blossom was introduced into a white one, the whole of the future seeds were coloured. But when the pollen of a white blossom was introduced into a coloured one, the whole of the future seeds were not white.

Mr Knight thinks his experiments on this subject afford examples of superfetation, a phenomenon the existence of which has been admitted amongst animals, but of which the proof amongst vegetables is not yet quite satisfactory. Of one species of superfetation Mr Knight had certainly produced examples; that is, when, by impregnating a white pea blossom with the pollen both of a white and gray pea, white and gray seeds were obtained. But of the other species of superfetation in which one seed is supposed to be the joint issue of two males, the example is not quite satisfactory. Such a production is perhaps possible, and further experiments may probably ascertain the fact; but it seems to be a matter of mere curiosity, and not apparently connected with any views of utility. But the utility of the experiments, in as far as they show the practicability of improving the species, is very obvious. And the ameliorating effect is the same whether by the male or female; as was ascertained by impregnating the largest and most luxuriant plants with the pollen of the most diminutive and dwarfish, or the contrary. By which means any number of varieties may be obtained, according to the will of the experi-

* Wildenow, p. 328.

menter, amongst which some will no doubt be suited to all soils and situations. Mr Knight's experiments of this kind were extended also to wheat; but not with equal success. For though some very good varieties were obtained, yet they were found not to be permanent.

But the success of his experiments on the apple-tree were equal to his hopes. This was indeed his principal object, and no means of obtaining a successful issue were left untried. The plants which were obtained in this case were found to possess the good qualities of both of the varieties employed, uniting the greatest health and luxuriance, with the finest and best flavoured fruit.

Many experiments of a similar nature were tried on other plants also; from which it appeared that improved varieties of every fruit and esculent plant may be obtained by means of artificial impregnation, as they were obtained in the cases already stated. Whence Mr Knight thinks that this promiscuous impregnation of species has been intended by nature to take place, and that it does in fact often take place, for the purpose of correcting such accidental varieties as arise from seed, and of confining them within narrower limits. All which is thought to be countenanced from the consideration of the variety of methods which nature employs to disperse the pollen, whether by the elastic spring of the anthers, the aid of the winds, or the instrumentality of insects.

But although he admits the existence of vegetable hybrids, that is, of varieties obtained from the intermixture of different species of the same genus, yet he does not admit the existence of vegetable mules, that is, of varieties obtained from the intermixture of the species of different genera; in attempting to obtain which he could never succeed, in spite of all his efforts. Hence he suspects that where such varieties have been supposed to take place, the former must have been mistaken for the latter. It may be said, indeed, that if the case exists in the animal kingdom, why not in the vegetable kingdom? to which it is perhaps difficult to give a satisfactory reply. But from the narrow limits within which this intercourse is in all cases circumscribed, it scarcely seems to have been the intention of nature that it should succeed even among animals.

More recent theories. The curious observations of Brongniart respecting the generation of plants, have thrown quite a new light upon this subject. When the grains of pollen are placed in contact with the surface of the stigma, they project their tubular appendage. The latter, when the surface of the stigma is naked, insinuates itself more or less deeply within the utricles of the stigma. The granules of the pollen quickly collect near the free extremity of the appendage, which swells and assumes a slight degree of opacity. The grain of pollen then shrivels and withers. Soon after, the extremity of the appendage opens, and the granules of pollen are laid bare, and come into contact with the mucilaginous substance of which we have already spoken, and which connects the utricles of the stigma. They are there seen in the form of little masses, which successively penetrate to a greater depth in the direction of the style. When the utricles of the stigma are covered by an epidermis, the tubular appendage is applied to the surface of this epidermis, and sticks to it by its extremity. Both then open, and the granules of pollen come into contact with the intercellular matter of the stigma.

The spermatic granules, adds Brongniart, therefore penetrate into the intercellular intervals of the stigma; but there they meet with no vessel for their conveyance, as some authors have alleged. Link thought they were transmitted through the walls of the cellules. Brongniart, on the contrary, says they pass through the intercellular spaces. In *pepo macrocarpus*, he says, the utricular tissue which connects the stigma and the ovules does not show globules in its intervals previous to fecundation; but, when the latter has taken place, the brownish streak produced by the spermatic granules may be very clearly traced in the yellow utricular tissue, and the granules are seen to reach the ovules. The spermatic granules are never contained in the cellules, but always appear in their intervals. This transmission appears to be effected in consequence of the hygroscopic qualities of the granules. When they have thus arrived at the ovule, the granules of pollen penetrate, by the opening which exists in its two membranes, as far as the kernel, passing either directly through the aperture, or, as Brongniart thinks, through a delicate membranous tube, which, issuing from the kernel, applies itself upon the placenta, and there takes up the fecundating granules, to convey them into the interior of the ovule. This tube terminates interiorly at the point where the embryo is to be formed, that is to say, at the vesicle which Malpighi named the *sac of the amnios.* This vesicle is, as it were, the mould in which the embryo obtains its form. After impregnation, there are seen to form in it opaque granules, often of a green colour, which at last form the embryo. The neck by which the vesicle was attached to the sac of the kernel contracts, breaks, and forms the radicle of the embryo.

Such is the theory of the generation of vegetables, as resulting from the observations of Needham, Smith, Amici, Robert Brown, and Brongniart. It will be seen to have a great analogy to the same phenomenon as observed in animals.

This explanation appears to be in accordance

with nature, in the greatest number of cases; but there are other circumstances in which the phenomena of fecundation are not produced in the same manner. In plants which are always submersed, it is evident that the grains of pollen do not attach themselves to the stigma and burst upon it; yet fecundation takes place in them as in other plants. The surface of the stigma of many plants is extremely smooth, and by no means clammy. That of the chestnut is hard and leathery. In these plants, the pollen cannot adhere to the stigma. In many of the orchis tribe, the pollen, in place of presenting a powdery substance, composed of an innumerable multitude of minute and light particles, forms an entirely solid mass. The anther opens; the mass of pollen retains its place, and remains perfectly entire; and yet fecundation is effected. Now, in this case, the pollen has not left the interior of the anther to be carried to the stigma, and there pour out its fecundating fluid. By the opening of the anther, it is merely placed in contact with the atmospheric air, and yet the plant is fecundated.

To account for these facts, several authors have supposed that, in plants, fecundation may, in some circumstances, be effected without the direct contact of the pollen with the stigma, and merely through the influence of a kind of emanation or *aura pollinaris*. But this question still remains undecided.

In the monœcious and diœcious plants, although the two sexes are separated, and often placed at a distance from each other, fecundation is not on that account prevented from taking place. In the case of diœcious plants, the pollen by which they are to be fecundated is transported often to great distances, by the air.

When the stamens and pistils are situated near each other, as in the case whether of hermaphrodite or monœcious flowers, the elastic spring with which the anther flies open will generally be sufficient to disperse the pollen, so as that part of it must infallibly reach the stigma. The facilities tending to ensure the access of the pollen as resulting from the relative proportion, situation, and mutual sympathies of the stamens and pistils, have been already noticed; as well as the possible action of winds wafting the pollen to a distance, and hence including the case of diœcious plants also. But with all the above facilities the impregnation of the seed would still, in many cases, be impracticable even in hermaphrodite flowers, without further aid; particularly in such as do not perfect their stamens and pistils at the same time. For although the action of the wind cannot but be efficacious in some such cases; yet it will, in some others, naturally give to the flower a direction calculated rather to prevent than to aid the access of the pollen, by causing the corolla to veer round like a vane according to the quarter from which it may happen to blow; or the very figure of the corolla may operate as a bar to the entrance of the pollen, which must be surmounted by extraordinary means.

What then are the means instituted by nature for effecting the impregnation of hermaphrodites so circumstanced? The true reply to this inquiry seems to have been first suggested by Koëlreuter, namely, the agency of insects; and has been since confirmed by the more leisurely observations of Spregnel, who found that the pollen in the above case is very generally conveyed from the anther to the stigma through the instrumentality of bees, though sometimes through that of insects of other species. The object of the insect is the discovery of honey, in quest of which, whilst it roves from flower to flower and rummages the recesses of the corolla, it unintentionally covers its body with pollen, which it conveys to the next flower it visits, and brushes off as it acquired it by rummaging for honey; so that part of it is almost unavoidably deposited on the stigma, and impregnation thus effected. Nor is this altogether so much a work of random as it at first appears. For it has been observed that even insects, which do not upon the whole confine themselves to one species of flower, will yet very often remain during the whole day upon the species they happen first to alight on in the morning. And their agency is also completely secured, from the necessity they are under of procuring food; though nature in her care for the impregnation of the vegetable has not only lodged a honey in the flower to tempt the taste of insects, but seems to have furnished also the means of attracting even the eye. This is thought to be done by means of the coloured spots with which many flowers secreting a honied fluid are marked, as indicating the treasure that is contained in the flower, and thus attracting the attention of the insect. But the very figure of the flower seems often intended to produce the same effect. Spregnel has enumerated several hundreds of flowers which in their figure as well as colour resemble insects, and hence attract the notice of the plunderers of their honied stores. The beautiful example of the bee orchis is known to almost every body.

Such then are the means by which the notice of the insect is attracted; and such also is the structure of the internal parts of the flower, that it must of necessity pass across the stamens and pistils in procuring the honey it is in quest of, which passage is often a work of considerable difficulty, particularly when the tubular part of the corolla is beset with hairs, as in many flowers of the class *pentandria* and *didynamia*. But one of the most difficult and singular cases of hermaphrodite impregnation, as aided by the

agency of insects, is that of the *aristolochia clematitis.* The corolla of this flower, which is tubular, but terminating upwards in a ligulate limb, is inflated into a globular figure at the base. The tubular part is internally beset with stiff hairs pointing downwards. The globular part contains the pistil, which consists merely of a germen and stigma together with the surrounding stamens. But the stamens being shorter than even the germen, cannot discharge the pollen so as to throw it upon the stigma, as the flower stands always upright, till after impregnation. And hence without some additional and peculiar aid, the pollen must necessarily fall down to the bottom of the flower. Now the aid that nature has furnished in this case is that of the agency of the *tipula pennicornis*, a small insect, which, entering the tube of the corolla in quest of honey, descends to the bottom and rummages about till it becomes quite covered with pollen; but not being able to force its way out again owing to the downward position of the hairs, which converge to a point like the wires of a mouse-trap, and being somewhat impatient of its confinement, it brushes backwards and forwards trying every corner, till after repeatedly traversing the stigma it covers it with pollen sufficient for its impregnation; in consequence of which the flower soon begins to droop, and the hairs to shrink to the side of the tube, effecting an easy passage for the escape of the insect.

Monœcious plants are, according to Spregnel, mostly impregnated by insects also, excepting such as are destitute of nectaries. But many of them do not require that aid, in which case the male and female flowers stand close together, as in *typha, coix, carex;* the females being lowest, and their petals being deeply or minutely laciniated so as not to interrupt the pollen in its fall, as in the genus *Pinus.*

The impregnation of diœcious plants is often effected by insects also, as has been already seen in the case of the fig, and their flowers are said to be always furnished with nectaries; the male flowers being larger than the female flowers, that the insect, as it has been thought, may have the better opportunity of loading itself with pollen.

From the fact of the agency of insects in conveying the pollen to the stigma, it will follow that no plant requiring such aid can possibly perfect its seed unless the specific insect has access to it, or unless some such aid is given to it by the cultivator. And hence botanists attribute the imperfection of the seeds of hot-house plants to the want of the insect by which the species may be impregnated in its native climate. This conjecture is countenanced by the following experiment, as related by Willdenow:—A plant of *abroma augusta* had flowered for many years in a hot-house at Berlin without producing any fruit; but when the gardener, by means of a hair pencil, placed a little of the pollen upon the stigma of several of the flowers, perfect fruit was produced, from which new plants were raised.

In diœcious plants, the palms, for example, fecundation may be artificially effected, as we have already stated. Linnæus even maintained that, not only may a single flower of a plant be artificially impregnated by this method, but that even a single cell of a multilocular ovary may be fecundated, by placing the pollen in contact with only one of the divisions of the stigma. It has been proved, however, that although the pollen should touch only one of the lobes of a stigma, all the cells of the ovary are equally fecundated. But in whatever manner fecundation has been effected, it always announces its influence by visible appearances. The flower, which until then was fresh, and often adorned with the most lively tints, soon loses its beautiful colouring, and resigns its transient splendour. The corolla fades, the petals wither and fall off. The stamina, having performed the functions for which nature had called them into existence, share the same fate. In a short time the pistil remains alone in the centre of the flower. The stigma and style, now become useless, also disappear. The ovary alone continues, it being in it that nature has deposited, to be there brought to maturity, the rudiments of future generations.

The ovary, when developed, forms the fruit. It is not uncommon to see the calyx remaining and accompanying it, until it attains its full maturity. It is to be remarked, that this takes place chiefly when the calyx is *monosepalous.* If the ovary is inferior or parietal, the calyx is then necessarily persistent, as it is intimately united to the ovary.

In the winter-cherry (*physalis alkekengi,*) the calyx remains after fecundation, becomes red, and forms a vesicular shell, in which the fruit is contained. In the narcissus, the apple, the pear, in short, in all plants which have the ovary inferior or parietal, the persistent calyx forms the outer wall of the fruit.

Shortly after fecundation has taken place, the ovary begins to enlarge. The ovules which it contains, and which are at first of a watery, and in some degree inorganic substance, gradually acquire consistence. The part which is to constitute the perfect seed, in other words, the embryo, gradually assumes development. All its organs acquire a decided form, and, in a short time, the ovary possesses the characters necessary to constitute a fruit.

We here conclude what relates to the flower properly so called, considered in a general point of view, and with reference to its constituent

parts. Before commencing our examination of the fruit, we have to describe an accessory organ of the flower, which is sometimes wanting, but which, when present, is of the greatest importance for the arrangement of plants in natural families. This organ is the *disk*.

It is distinguished into *hypogynous*, *perigynous*, and *epigynous*.

1. The *hypogynous disk* bears the name of *podogynum* when it forms a fleshy body, distinct from the receptacle, and which raises the ovary above the bottom of the flower; as in the rue, and the other species of the family of Rutaceæ. It is named *pleurogynum*, when it comes off under the ovary and rises upon one of its lateral parts; as, for example, in the periwinkle. It is called *epipodium*, when it is formed of several tubercles which come off upon the support of the ovary. This variety of disk is observed especially in the plants of the family of Cruciferæ, as the mustard, turnip, &c.

2. The *perigynous disk* is formed by a more or less thick fleshy substance, spread out upon the inner wall of the calyx, as in the cherry, the almond, and certain species of *diosma*, which, in this respect, differ from the other species of the same genus.

3. The *epigynous disk* is that which is observed upon the summit of the ovary when the latter is inferior, that is, when it is attached by every part of its outer surface to the tube of the calyx, as in the umbelliferæ, (carrot) and rubiaceæ, (gallium.)

The *insertion* of the stamina is distinguished into *absolute* and *relative*. The first of these terms applies to the position of the stamina, without reference to the pistil. Thus we say: stamina inserted into the corolla, the calyx, &c. The second applies to the position of the stamina or of the staminiferous monopetalous corolla, with relation to the pistil. Thus we say: stamina inserted beneath the ovary, around the ovary, or upon the ovary.

There are thus distinguished three kinds of insertion, which are named *hypogynous*, *perigynous*, and *epigynous*. The *hypogynous insertion* is that in which the stamina, or the monopetalous corolla bearing the stamina, are inserted under the ovary; as in the cruciferæ, labiatæ, &c. The *perigynous insertion* is that in which the stamina are inserted into the calyx, as in the rosaceæ, (the wild rose.) Lastly, in the *epigynous insertion*, which takes place whenever the ovary is inferior, the stamina or the staminiferous monopetalous corolla are inserted upon the summit of the ovary. The umbelliferæ, rubiaceæ, &c., afford examples of this kind of insertion.

The position of the disk generally determines the insertion. Thus, whenever there is a hypogynous disk, the insertion is hypogynous. It is perigynous, when the disk is so. Lastly, it is epigynous, whenever there is an epigynous disk upon the summit of the ovary.

CHAP. XVI.

THE FRUIT AND ITS ENVELOPES.

In the progress of fructification, when the several organs of the flower have discharged their respective offices, the petals, the stamens, the style, and often the calyx, wither and fall. The ovary alone remains attached to the plant, and swells and expands till it reaches maturity. It is now denominated the fruit. But at the period of its complete development, it also detaches itself from the plant and drops into the bosom of the earth, containing and protecting the embryo of the future vegetable. The fruit then is the ripened ovary, and the parts which it contains. In popular language the term is confined chiefly to such fruits as are eatable, as the apple, peach, cherry, or perhaps to the esculent part only; but with the botanist, the matured ovary of every flower, with the parts contained, constitutes and is termed the fruit.

As the fruit consists of the ripened ovary, it follows that the situation and distribution of the fruit must be the same with that of the flower which has preceded it. If the flower was radical or caulinary, so is the fruit. If it was lateral, axillary, or terminating, so is the fruit. If it was sessile or pedunculate, spiked or verticellate, so also is the fruit. And for the same reason, if the ovary was detached, the fruit must also be detached. Or to express these modifications in language perhaps more correct, if the flower was inferior, the fruit will be inferior; if the flower was superior, the fruit will be superior; and if the flower was intermediate, the fruit will be intermediate. It does not follow, however, that mere modifications of position shall be the same, because it frequently happens that plants of which the flower has been drooping, the fruit is erect, as in the lily and cowslip; and, on the contrary, that of plants of which the flower has been erect, the fruit is drooping, as in wheat and barley. The figure of the fruit assumes almost as much variety as that of the flower, but the following are its most frequent modifications. It is either spherical, as in the cherry; or elliptical, as in the almond; or oblong, as in the coffee-berry; or cylindrical, as in *epilobium;* or inversely conical, as in the pear; or inversely heart-shaped, as in veronica; or kidney-shaped, as in *anacardium;* or three-cornered, as in the tulip; or twisted, as in *mecago satira;* or jointed, as in *hedysarum;* or inflated, as in *staphylea;* or winged, as in crown imperial; or stellate, as in the poppy. The apex

is described also as being acute, as in sago; or obtuse, as in the filbert; or truncated, or emarginate, as in *thlaspi;* or umbellicate, as in the apple. The size of the fruit is also very various, but is not always in proportion to the plant that produces it. The oak and the ash, though among the largest of trees, produce a fruit that is comparatively but very diminutive, while the gourd, whose stem is but herbaceous and creeping, produces a fruit of a most enormous bulk. The largest fruits occur amongst the palms, or among cucurbitaceous and leguminous plants. The fruit of a palm called *leontarus malderica*, is often a foot and a half in diameter; and that of *mimosa scandens*, often six feet in length. The fruit in its immature state is always soft and pulpy; but in its matured and ripened state it is generally firm and compact, and sometimes so very hard that it can scarcely be cut. In the cherry it is succulent, in the strawberry pulpy, in the apple fleshy; in *staphylea* it is membranaceous; in the elm tree leathery, in the nut woody. But it is very seldom of the same consistence throughout. For sometimes the outer part is soft, and the inner hard, as in the peach and cherry; and sometimes the outer part is hard, and the inner soft, as in the filbert and cocoa nut, while sometimes both parts are alike, as in the pine apple. Some fruits are covered with a thick rind, many with a thin cuticle only. The cuticle may be seen in succulent berries, and the rind or bark in the orange, lemon, and cocoa nut. The bark is in general closely attached to the interior part, but sometimes it is remote from it, and inflated. In its exterior surface it is generally smooth and uniform, as in the cherry; or cottony, as in peony; or scaly, as in sago; or dotted, as in the orange; or perforated with holes, as in the bread-fruit, (*artocarpus;*) or ribbed, as in the melon; or rough, as in *gallium aparine;* or set with tubercles, as in *onobrychus;* or with prickles, as in *canna indica;* or with thorns, as in *trapa*. It is also often beautifully twisted. When the blossom begins to fade, and the colour of the corolla to decay, the beauty of the plant seems to have departed with the departing flower. But these tints are often more than compensated by the rich and mellow colouring of the fruit. The ripened tints of autumn are found to be equally pleasing with the bloom of spring; and the colour of the peach and apricot, the plum and the cherry, are in nothing inferior to the hues which preceded them. Nor are fruits ornamental only. They evidently exhibit one of those arrangements of nature, by which a beneficent Providence accomplishes two important ends by one means. For not only do pulpy fruits and seeds afford the necessary nourishment to the germ of the future plant, but they also furnish important articles of food to man and the lower animals.

Fruits are said to be single when a flower produces only one seed, or several seeds contained in a single seed-vessel. When many seeds are produced either detached or united, except by one style, the fruit is said to be multiplicate. The number of the fruit produced by one individual flower, is not, however, always the same, even in the same species, because all the original ovaries are not always impregnated. If the fruit is produced in pairs, as in umbelliferous plants; or in threes, as in the lily; or in fours, as in verticellate plants; or in fives, as in the geranium; or in an indefinite number from the same flower, as in the rose and ranunculus; it is then said to be conjugate, or compound. The compound fruit is either lobed or divisible. It is divisible if in its immature state it presents a uniform and integral appearance, but afterwards separates into distinct portions, as in the pod of the pea and bean. It is lobed if the portions into which it may separate are attached to a common axis, as in meadow saffron, (*colchicum.*) There is also another species of compound fruit, distinguished by Gærtner, which is formed by the union of two or more ovaries of different flowers, combined into one whole, as in *caprifolius* and *artocarpus*.

Such are the general and external modifications of the fruit considered as a whole; we now proceed to describe its constituent parts, consisting exteriorly of the *pericarp*, and interiorly of the seed.

The *pericarp* is that part of a ripe and perfect fruit formed by the walls of the fecundated ovary, and containing one or more seeds. It determines the form of the fruit.

The pericarp is never wanting, but it is sometimes so thin, or so intimately united to the seed, that it can hardly be distinguished in the ripe fruit, so that, many authors imagining it not to exist, have said that the seeds are *naked;* as in the labiatæ, umbelliferæ, and synanthereæ. But it is now proved that there are no *naked* seeds, and that the pericarp is never wanting. The pericarp commonly presents, on some part of its outer surface, generally towards the highest part, the remains of the style or stigma. According to Richard, the pericarp is always formed of three parts, viz. 1st, The *epicarp*, an external thin membrane, or kind of epidermis, which determines its form, and constitutes its outer covering; 2dly, An internal membrane which is spread over its seed-bearing cavity, and which has received the name of *endocarp;* 3dly, Between these two membranes, a parenchymatous and fleshy part, which is named *sarcocarp* or *mesocarp*. These three parts, intimately united, form the pericarp.

When the ovary is inferior, that is, whenever it is united to the tube of the calyx, the *epicarp* is formed by the tube of the calyx, the paren-

chyma of which is confounded with that of the *sarcocarp*. In this case it is always easy to distinguish the beginning of the *epicarp*, as at its upper part, at a variable distance from the point of origin of the style and stigma, it presents a more or less prominent rim, formed by the remains of the limb of the calyx, which disappeared after fecundation.

The *sarcocarp* or *mesocarp*, is the parenchymatous part, in which are found collected all the vessels of the fruit. It is excessively developed in fleshy fruits, such as peaches, apples, melons, and pumpkins; all the fleshy part of these fruits is formed by the sarcocarp.

The *endocarp*, or internal membrane of the fruit, is that which lines its internal cavity. It is almost always thin and membranous. Sometimes, however, it is thickened externally by a greater or less portion of the *sarcocarp*. When this part of the sarcocarp becomes hard and bony, it envelopes the seed, and constitutes what is called a *nut*, when there is only one seed in the fruit, and *nucleus* when there are several.

When the pericarp is dry and thin, it might at first be thought that there is no *sarcocarp*. Were this term always to imply a thick, fleshy, and succulent part, no doubt it would very frequently be wanting; but the peculiar and distinctive character of the sarcocarp consists in its being the truly vascular body of the *pericarp;* in other words, it is formed by the vessels which nourish the whole fruit. Now, as the pericarp always contains vessels, the sarcocarp is never wanting, although it is sometimes very thin when the fruit, having attained its full maturity, has dried. But, if the pericarp be examined with attention, there will be seen between the *epicarp* and *endocarp*, ruptured vessels by which they were connected, and which are the remains of the *sarcocarp;* for, as that part is always full of aqueous juices previous to the maturation of the fruit, when the fluid which it contains has evaporated, it seems at first sight to have entirely disappeared.

The internal cavity of the pericarp, or that which contains the seeds, may be *simple*, in which case the pericarp is said to be *unilocular*, or *one-celled;* as in the white poppy. At other times, there are several *cells* or partial cavities, whence the terms *bilocular*, *trilocular*, *quinquelocular*, *multilocular*, applied to the pericarp, according as it has two, three, five, or more, distinct *cells*. The *cells* of a pericarp are separated from each other by vertical laminæ, which take the name of *partitions* or *dissepiments*. All true *partitions* are formed in the same manner. The *endocarp* is prolonged into the interior of the cavity of the pericarp, in the form of two lamellar processes, placed back to back, and connected usually by a very thin prolongation of the *sarcocarp*. This is the mode of formation of all the *true* partitions. Those which are differently constructed must be considered as *false*.

In certain partitions, it sometimes happens that the parenchymatous part of the sarcocarp, which unites the two laminæ of the endocarp, dries up, when the two laminæ disunite and separate to some distance, so as to present the appearance of an additional number of cells. But these spaces may easily be distinguished from true cells, by observing that the two laminæ of the endocarp have one of their sides covered with broken vessels. Besides their mode of origin and formation, another distinctive character of the *true partitions* is, that they always alternate with the stigmas or their divisions. Certain fruits, on the other hand, present *false partitions* in their internal cavity. Such are those of some cruciferæ, many cucurbitaceæ, the poppy, &c. The *false* are distinguished from the *true* partitions: 1st, By their not being formed by a duplicature of the *endocarp* properly so called; and, 2dly, By their generally corresponding to the stigmas or the divisions of the stigma, instead of being alternate, as the true partitions are.

The partitions are further distinguished into *complete* and *incomplete*. The first are those which extend internally from the upper part of the cavity of the pericarp to its base, without any interruption. The incomplete partitions are not continuous from the base to the summit, but leave a communication between the two cells. *Strammonium*, or thorn apple, presents an example of both these kinds of partitions existing together in the same fruit. If the fruit of that plant be cut across, it presents four *cells*, and consequently four *partitions;* but of these partitions two only are *complete*, while the other two do not reach the top of the internal cavity of the pericarp, but rising only to two-thirds of its height, allow the two cells, which they separate below, to communicate together at their upper part.

To be able to know and name correctly the different parts which compose the pericarp, and to distinguish them from those which belong to the seed, it is of the greatest importance to establish the precise limits between these two organs. As every seed must receive its nourishment from the pericarp, it necessarily follows that it must communicate with it by some part of its surface. This point of communication has been named the *hilum* or *umbilicus* by botanists. The *hilum* is to be considered as the precise limit between the pericarp and the seed; in other words, all the parts which occur externally of and above the hilum belong to the *pericarp*, while all those which are situated beneath the hilum, are to be considered as forming part of the *seed*.

The seeds are attached within the pericarp to a peculiar fleshy body, varying in size and form, to which the name of placenta or *trophosperm* is

given. The *endocarp* is always perforated at the internal point of the pericarp, to which the *trophosperm* is attached, because the *sarcocarp*, being the only vascular part of the pericarp, and the only one that can furnish the materials required for the nutrition of the seed, it is necessary that the *endocarp* should have an opening to allow a passage to the vessels which go to that organ.

The *trophosperm* sometimes bears only a single seed, but at other times supports a great number. When its surface presents obvious prolongations, each of which supports a seed, these prolongations are named *podosperms;* as, for example, in the pea, and bladder campion.

The *trophosperm*, or the *podosperm*, commonly stop short around the hilum of the seed. When they are prolonged beyond that point, so as to cover the seed to a greater or less extent, the prolongation takes the name of *arillus*.

The *arillus* being merely an expansion of the *trophosperm*, does not belong to the seed, as it is generally said to do, but to the pericarp.

The partitions are usually *longitudinal*, so as to extend from the base to the top of the pericarpal cavity. In some very rare cases, as in *cassia, fistula*, and a few other leguminosæ, they are *transverse*. These partitions are further distinguished into *complete* and *incomplete*. The origin of the *false partitions* is exceedingly variable. Sometimes they are formed by a more or less considerable projection of the trophosperm, as in the poppy: sometimes by a prolongation inwards of the edges of the pericarpal *valves*, &c.

The *trophosperm* is that part of the *pericarp* to which the seeds are attached. Sometimes it presents at its surface a greater or less number of small projecting mammillæ, each supporting a single seed, and which are named *podosperms*.

When a pericarp is *multilocular*, the trophosperm generally occupies its centre, and is then named *central*. In this case, it is formed by the meeting and union of the partitions, and in the internal angle of each cell presents a greater or less projection.

The *arillus* belongs essentially to the pericarp, it being merely a prolongation of the trophosperm. It is therefore incorrect to consider it, as many botanists do, as forming part of the seed, upon which it is merely applied, without at all adhering to it, excepting around the hilum. Few parts of plants exhibit so many varieties in their form and nature as the arillus. It is consequently very difficult to give a strict definition of it, which may be applicable in every case.

In the nutmeg (*myristica officinalis*), the arillus forms a fleshy covering, of a light red colour, divided into narrow and unequal shreds. This is the part which is used in pharmacy, and is known by the name of mace. *Polygala vulgaris* has a three-lobed arillus of small size, forming a kind of little crown at the base of the seed. In the common spindle-tree (*euonymus europæus*), and the broad-leaved species of the same genus (*euonymus latifolius*), the arillus, which is of an orange colour, envelopes and conceals the seed on all sides. In *euonymus verrucosus*, it forms an irregular cup, which is open above.

From the small number of examples given above, it will be seen that the arillus varies exceedingly in colour as well as in form and consistence; but, as its origin is the same in all cases, it is easily distinguished, notwithstanding the numerous forms under which it may present itself. Various parts have often been taken for arilli; for example, the outer, obviously fleshy part of the proper integument of the seed, in the jasmine, the *endocarp*, as in the coffee (*coffæa arabica*), the rutaceæ, &c. It is a general law, to which no exception has yet been found, that the arillus is never met with in plants which have a *monopetalous corolla*. The *tabernæmontana* might seem to form an exception; but, when better examined, its alleged arillus is merely the outer part of the proper integument of the seed, which is soft and fleshy.

Having examined the component parts of the pericarp, the partitions, the cells, the trophosperm and the arillus, let us return to the pericarp considered in a general point of view.

In the pericarp, as in the ovary, there are distinguished: 1st, The *base*, or the point by which it is fixed to the receptacle or the peduncle; 2dly, The *summit*, which is indicated by the place formerly occupied by the style or the sessile stigma; 3dly, The *axis*. Sometimes the axis is not merely imaginary, but has a real existence, and is named the *columella*. At other times it is fictitious, or is represented by an imaginary line, passing through the centre of the pericarp, from its base to its summit.

The *columella* forms a kind of little pillar, on which are supported the different pieces of the fruit, and which remains at the centre of the pericarp, when these have fallen off; as in the euphorbiæ and umbelliferæ.

The seeds being enclosed in the pericarp, it becomes necessary, to allow them to issue at the period of their maturity, that the pericarp should open in some manner. The name of *dehiscence* is given to the action by which a pericarp naturally opens. There are pericarps, however, which do not open, and which are termed *indehiscent;* as in the synanthereæ, labiatæ, gramineæ, &c.

Among the pericarps which open naturally at the period of maturity, there are distinguished: 1st, The *ruptile pericarps*, or those which burst into irregular pieces, of which the number and form are very variable; 2dly, Those which open only by holes formed at their upper part, as in the genus *antirrhinum;* 3dly, Those which open

at their summit by teeth, which are at first close together, but which separate from each other, as in many caryophylleæ; 4thly, Those which separate into a determinate number of distinct pieces, which are named *valves*. These latter are the truly *dehiscent pericarps*. The number of valves in a pericarp may always be learned by the number of longitudinal seams or *sutures*, which are observed upon its outer surface. The true valves are of the same number as the cells of the pericarp. Thus a *dehiscent* fruit, which is *quadrilocular*, has *four* valves. There are some exceptions, however. The capsule of the violet is a single cell, and opens into three valves. In some fruits, each of the valves separates into two pieces, so that the number of the former seems double what it ought naturally to be.

A pericarp is called *bivalve*, when it separates of itself into two equal and regular valves; as in the lilac, and the speedwells. *Trivalve*, when it opens into three valves; as in the tulip, the lily, the violet. *Quadrivalve*, or with four valves; as in the genus *epilobium*, and the thorn-apple. *Quinquevalve*, opening with five valves. *Multivalve*, when it divides into a greater number of valves or distinct segments.

The opening of the valves may take place in different ways, agreeably to the relative position of the valves and partitions. It may take place at the middle of the cells, or between the partitions which then correspond to the middle part of the valves. This is observed in most of the ericineæ. At other times the opening takes place opposite the partitions, which it usually divides into two laminæ; as is seen in the scrophularineæ, and rhodoraceæ. Lastly, the bursting may take place towards the dissepiment, which remains free and entire at the moment when the valves separate; as in the *bignoniæ* and *calluna vulgaris*. Most commonly the opening takes place by longitudinal sutures. In some cases, however, these sutures are transverse, and the valves are superimposed upon each other; examples of which are seen in the henbane, the pimpernel, and the plantain. The fruit may be crowned by the teeth of the calyx, when the ovary is inferior or parietal, as in the pomegranate, the apple, the pear. At other times, it is surrounded by a tuft of bristly hairs (the *pappus*), which is to be considered as a true calyx. This is the case in almost all the species of the extensive tribe of synanthereæ.

The pappus may be *sessile*, or applied directly upon the summit of the ovary, without the aid of an intervening body; as in the genera *hieracium*, *sonchus*, *prenanthes*, fig. *a*. In other genera, it is supported upon a small pivot or stalk, which is named the *stipe*, and the pappus is said to be *stipitate*, as in the lettuce and dandelion, &c., fig. *b*. The *hairs* of which the pappus is composed, may be *simple*, or undivided, in which case the *pappus* is said to be *pilose* or *hairy*. At other times they are *feathery*, or have on their

57.

a b

sides other shorter and finer hairs, resembling the barbs of a feather. The *pappus* is then named *plumose* or *feathery*.

In the valerians, the *pappus*, which is obviously nothing but the limb of the calyx, is at first rolled up within the flower, and appears in the form of a small circular rim at the upper part of the ovary; but, some time after fecundation, it is seen to stretch out, elongate, and form a true *feathery pappus*.

The pericarp also not unfrequently presents membranous appendages in the form of *wings;* as in the elm and maple. According to the number of these appendages, it is named *dipterous*, *tripterous*, *tetrapterous*, &c. Sometimes it is covered with long, stiff hairs, as in *lontarus;* or is stuck over with spines, as in the horse-chestnut and thorn-apple.

As every *fruit* is composed of two parts, the *pericarp* and the *seed*, we have first to distinguish these two parts from each other. We know that the seed is always contained within the pericarp. If we cut a peach in two, we shall find its centre occupied by a cavity or cell, containing a single seed, rarely two. The *seed* once distinguished, all that is placed externally of it, according to Richard, belongs to the *pericarp*, and he thus enumerates its different parts. In the first place, we find, at the outside of the whole, a thin, coloured pellicle, covered with a very short down, which is easily removed. This pellicle is the *epicarp*. The internal cavity of the *pericarp* is lined by a smooth membrane, intimately united to, and confounded with, the hard part which forms the nut or shell. This membrane is the *endocarp*. All the thick, fleshy, spungy part, contained between the endocarp and the epicarp, forms the *sarcocarp*. But to which of these three parts belongs the bony shell which we observe within? Is it, as was long supposed, a proper integument of the seed, a thick and woody *endocarp*, or is it part of the *sarcocarp*? These questions can easily be solved by examining how this hard part is formed. If we take a young peach, long before it is ripe, and cut it through, we find no resistance, there being as yet no solid shell in it. At this period, the

three parts of the *pericarp* are extremely distinct from each other, and the *endocarp* is here evidently under the form of a mere membrane applied upon the internal surface of the sarcocarp. But, shortly after, we see the part of the sarcocarp nearest this inner membrane gradually becoming whiter and denser, and passing through all the intermediate stages, before acquiring the bony solidity which it presents at the period of maturity. Now, in this case, although this portion of the *sarcocarp* is intimately united and confounded with the *endocarp*, it cannot by any means be referred to the latter, but belongs to the sarcocarp, as it is really formed by it. The shell, or the bony part which is found at the centre of the peach, is therefore formed by the *endocarp*, to which is joined an ossified portion of the *sarcocarp*. What we have here said of the peach is equally applicable to the apricot, the prune, the cherry, and the almond. Such are Richard's views of the pericarp, but other botanists are still disposed to consider the shell of such seeds as distinct from the soft enveloping pulp.

If we now take the fruit of the common pea and analyze it, we find it to be elongated and compressed so as to present two short edges, along which run two longitudinal *sutures*. This circumstance shows that, when ripe, it will open in two segments or *valves*. It is, therefore, a bivalve pericarp. On cutting it longitudinally, we find only a single internal cavity, containing from eight to ten seeds. Thus it is *unilocular* and *polyspermous*. The seeds are all fixed, along the upper suture, to a small thick margin, running along the suture, and giving off a distinct prolongation to each seed. All that occurs externally of the seed forms part of the pericarp. At the outer surface is a thin membrane, which adheres closely to the adjacent part: it is the *epicarp*. The internal cavity is lined by another membrane, not quite so closely adhering: it is the *endocarp*. The fleshy, green, and vascular part, which is observed between these two membranes, although of no great thickness, is the *sarcocarp*. The small longitudinal prominence which runs along the *suture*, and to which the seeds are attached, is the *trophosperm*. Each little prolongation connecting a seed with that body is a *podosperm*.

We thus see that the pericarp is the part of the fruit which forms the walls of the simple or multiple cavity in which the seeds are contained: that it is always composed of three parts: 1*st*, The *epicarp*, or membrane by which it is covered externally; 2*dly*, The *endocarp*, or internal parietal membrane lining its internal cavity; 3*dly*, A more or less thick and fleshy part, which, however, is sometimes thin, and not easily perceived, but always vascular, and which is named the *sarcocarp* or *mesocarp;* and that the pericarp is often divided internally by *partitions* into a greater or less number of *cells*, when it is called *bilocular*, *trilocular*, *quadrilocular*, *multilocular*, &c. The point of the cavity of the pericarp to which the seeds are attached presents a fleshy prominence, of variable size, coming off from the sarcocarp, which has received the name of *trophosperm*. The *podosperm*, again, is the little process of the *trophosperm* which supports the seed. When the *trophosperm* or the *podosperm* cover the seed, so as to embrace it over a considerable extent, the peculiar prolongation by which this is effected bears the name of *arillus*.

Fruits, considered in a general point of view, have been divided in various ways, and have received particular names. Thus, the name of *simple* fruit has been given to that which proceeds from a single pistil, contained in a flower; of which kind is the peach, the cherry, &c. A *multiple* fruit, on the contrary, is that proceeding from several pistils contained in the same flower: for example, the rasp, the strawberry, the fruit of the genera *ranunculus*, *clematis*, &c. Lastly, the name of *compound* fruit is given to that which results from a greater or less number of pistils placed close together, and often united, but all coming from distinct flowers situated very near each other; as in the mulberry.

According to the nature of their pericarp, fruits are distinguished into *dry* and *fleshy*. Dry fruits are those whose pericarp is thin, or formed of a substance generally containing little juice. Fleshy fruits, on the contrary, have a thick and succulent pericarp, and their sarcocarp in particular is very large. Of this kind are melons, peaches, apricots, &c. Fruits may remain entirely closed in all parts, or may open into a determinate number of pieces named *valves*. From these circumstances, they are distinguished into *dehiscent* and *indehiscent*. The latter, when they are dry, are also named *capsular* fruits. According to the number of seeds which they contain, they are divided into *oligospermous* and *polyspermous*. Oligospermous fruits are those which contain only a small number of seeds, which, in most cases, is precisely determined: whence the epithets *monospermous*, *dispermous*, *trispermous*, *tetraspermous*, *pentespermous*, &c., applied to the fruit, to denote that the number of its seeds is one, two, three, four, five, &c. *Polyspermous* fruits are all those which contain numerous seeds, the precise number of which it is unnecessary to determine.

The form and structure of the pericarp, being so various in different plants, botanists have found it extremely difficult to arrange them under any systematic classification; the following distinguishing forms, however, can be always recognized: the capsule, the pome, the berry, the nut, the drupe, the silique, the legume, and the cone.

The *capsule* is a dry and membranaceous peri-

carp, separating for the most part, when ripe, into valves, or at least opening in some definite and determinate manner; it is seen in the snow drop, bell flower, and poppy. It is one valved, as in *primula*, two valved as in *cercoa*, many valved as in *oxalis*, or without valves, as in the *ash*. In the lily the valves are vertical, in anagallis they are transverse, in meadow saffron they are introflected. It is one celled as in the violet, two celled in veronica, three celled in the iris, or many celled as in the andromeda. In convolvolus, the partitions are central, in the poppy they are marginal and incomplete, in the tulip they are perpendicular to the valves, and in the water lily they bear the seed. In the *iris*, the opening is longitudinal, in *hydiciamus* it is horizontal, in *silene* it is at the apex, in *phytuna* at the side, and the *triglochin* at the base. In some cases the varieties of form and structure which the capsule assumes, are so striking or peculiar as to have been thought worthy of being designated by proper names, as the *utricle*, *samara*, *bag*, and *coccus*. The *utricle* is a small and bladder-like capsule, without valves, consisting of one cell, and one seed, as seen in the clematis and cheropodium. In *gallium* it is light, closely investing the seed; in *adonis* and *thalictrum*, it is loose. In *amaranthus* it bursts horizontally in the middle, and in *cheropodium* it is so tender as to be easily rubbed off with the finger.

The *samara* is a compressed and leathery capsule, of one or two cells, but without valves, terminating in a membranaceous wing or border, and falling off entire with the contained seed by which it is irregularly burst open in the process of germination, as in the ash, elm, and maple.

The *bag* is an elongated and leathery capsule, consisting of one valve and one cell, and opening longitudinally on the one side. It is sometimes single, but more frequently double, with the seeds loose or attached to a proper receptacle, which is generally the edge of the seam by which it opens, as is seen in the genus *vinca* or *pœoma*.

The *coccus* is a dry and elastic capsule, of two or more lobes joined together, each forming a cell, and containing a seed, but separating, when ripe, from the axis, and bursting longitudinally into two valves united at the base. It is two celled, as in *mercurialis*, three celled in *euphorbia*, many celled as in *puracrepitans*, the valves of which latter, it is said, when fully ripe and dry, frequently burst open with a sudden and violent jerk, so as to produce an explosion like the report of a pistol.

58.

Apple.

The *pome* is a pulpy or fleshy pericarp, without valves, but inclosing a capsule. It is exemplified in the familiar case of the apple, from the Latin appellation from which it has taken its name. It is generally of a globular or oval figure, as in most varieties of the apple, but sometimes it is inversely conical, as in the pear. At the apex it is marked with a small cavity, surrounded by the remains of the calyx, which is persistent, or in the language of other botanists, adherent; this cavity is the *umbilicus*, or eye of the fruit; at the base there is often also a small cavity formed by the expansion of the pome, around the insertion of the foot stalk, which has not received any particular name; in the pear, the pome tapers down gradually to the point of insertion, and renders the cavity less distinct. The enclosed capsule is a thin and membranaceous substance, consisting, for the most part, of five distinct cells.

59.

Strawberry.

The *berry* is a soft and pulpy pericarp, containing one or more seeds, but not separating into regular valves, nor enclosing a capsule. It is exemplified in the common gooseberry, currant, and strawberry. It is not, however, always strictly succulent, for in the ivy it is of a dry and mealy nature, and in *trientalis*, it is covered with a sort of brittle crust. The same may be said of the gourd, melon, and cucumber, together with the lemon, and orange, which though regarded by botanists as being varieties of the berry, are yet covered with a thick coat or rind, which is not pulpy. The seed vessel of cucurbitaceous plants is even distinguished by the peculiar name of *peps*, and characterized by having its seeds situated remote from the axis, and inserted into the sides of the fruit; the figure of the berry is for the most part globular, as in *vaccinium*, but in the strawberry it is oval. In *daphne*, it is one seeded, in asparagus it is generally two seeded, in the ivy three seeded, in *nymphœa* many seeded. Sometimes the seeds are irregularly dispersed in the pulp, as in *nymphœa*; sometimes they are attached to a common receptacle, as in *solanum;* and occasionally the cells are separated by regular partitions, as in the lemon. In the foregoing examples the berry is said to be simple when it consists of only one ovary, but sometimes it is compound when several ovaries are inserted into one mass, as in the bramble and bread fruit. In this case, each ovary contains a seed, and the individual ovaries are also farther designated by the peculiar appellation of *acini*. It should be observed, however, that the berry of the bramble is composed of the united ovaries, of only a single flower; while that of the bread fruit is composed of the united ovaries of many flowers. Several other fruits, though not corresponding

exactly to the above definition or exceptions, are regarded, however, by botanists as being also varieties of the berry, such particularly as those of the juniper and yew tree. In the former the scales of the fertile catkin, which ultimately become succulent, unite also together and form a globular fruit, resembling a berry so much as to have obtained the name. In the latter, the calyx or receptacle, as it is generally believed to be, which is at first a thin and scaly like substance, of a whitish or greenish complexion, embracing merely the base of the ovary, expands and enlarges into a thick and pulpy envelope, of a bell shaped figure, and of a most beautiful red, investing the whole of the ovary except the mouth or open extremity, and giving the fruit the appearance of a berry, as it is generally called, though, strictly speaking, it is more properly a nut than a berry.

60.

Acorn.

The *nut shell* is a pericarp of a hard woody texture, though sometimes of the consistence of leather; it rarely opens spontaneously, or if it does so, it divides into two valves only. The acorn and filbert are examples of the hard nut; the chestnut of the soft leathery. In the genus *echium*, the pericarp is crustaceous, and in *myosotis* as hard as flint. The figure of the nut shell is generally spherical or oval, sometimes it is angular. The acorn is a single celled fruit, and one seeded, in consequence of the constant abortion of several ovules. It proceeds from an inferior many celled and many seeded ovary, of which the pericarp is intimately attached to the seed, and always presents at its summit the very minute teeth of the limb of the calyx, and is in part contained in a kind of scaly or leafy involucre, named the cup. In *trapa* it is two celled, and in the chestnut six celled, but the partitions are not perceptible in the mature state of the fruit. The contained seed or nut is generally denominated the nucleus, and is extricated for the most part, by means of a fissure, effected in the process of germination, or by the gradual decay of a part. But in the walnut the shell opens spontaneously into two valves, and in the filbert, in which it does not perhaps open spontaneously, the valves seem at least to be marked out by a sort of superficial line, and are easily divided with the assistance of a knife. In *lycopsis* it opens by a hole or fissure at the base, and in *trapa* by a hole at the apex. Sometimes it is naked, as in lycopsis; while in other cases it is coated or covered with a membranous envelope, either wholly or in part, as in the acorn and walnut.

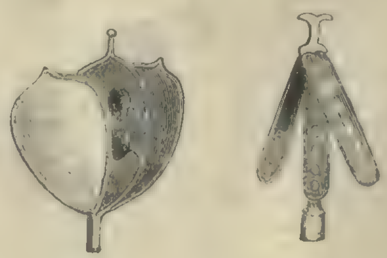
The *drupe* is a soft and pulpy pericarp, without valves, but inclosing a nut. It may be

61.

Cherry.

exemplified in what is generally called stone fruit, as in the cherry, the peach, the apricot. It is generally round, as in the cherry; or elliptical, as in the apricot. In the genus *helesia* it is winged. Its substance is succulent, as in the plum; or fibrous, as in the cocoa-nut; or dry and leathery, as in the almond, *sparganium* and *gaura*, which last are nearly allied to nuts. It opens for the most part merely by accident or decay, but in the peach, and perhaps a few others, it opens spontaneously. The shell of the drupe is generally very hard, whence the term stone fruit. But in some cases it is soft and tender, as in *styrax callaphyllum;* in some it is leathery, as in *hyphenæ;* and in some woody, as in *cerbera*. It does not, perhaps, in any case open spontaneously, and yet there are some shells in which the traces of valves may be discerned, as in that of elæocarpus; or in which a division may easily be effected, by means of the knife, as in *prunus*. Incomplete valves indeed are sometimes found at the top of the shell, as in nitraria and gaura, so as to make it resemble a toothed capsule; and in a few genera there is an opening formed by means of a hole or pore at the top, as in cocoa-nut. The figure of the shell is very often elliptical or egg-shaped, but compressed, assuming, however, a great variety of modification, sufficient, in most cases, to determine species. Its surface is never quite smooth, but often rough, and irregularly furrowed, as in the peach; in order, perhaps, that it might the more closely unite with the exterior part of the fruit. Sometimes the shell is separable into several different divisions, each forming an enclosed cavity, and containing a seed. In this case each division assumes the appellation of a *pyrena*, and the fruit is said to be *deperenous*, *treperenous*, or *polyperenous*, according to the number of divisions into which it separates. The partitions, however, as in the compound nut, are effaced in the matured fruit.

62.



a *b*

The *silique* or *pod* is a dry and elongated pericarp, consisting of two valves with two op-

posite seams, to which the seeds are alternately attached. It is said to be siliculous, if the transverse and longitudinal diameters are equal or nearly so, as in *thlaspi*, fig. *a*; and siliquose, if the longitudinal diameter exceeds the transverse, so as to give to the pod the oblong figure, as in *cheiranthus*, fig. *b*. In *brassica* the pod is cylindrical, in *crysiumum* it is four cornered, in *lepidium* it is elliptical, and in *thlaspi* it is inversely heart-shaped. The surface of the pod is generally smooth or pubescent, but in raphanus and sinapis, it is covered with protuberances. Though the valves are generally two, yet the pod of the genus bunias is wholly without valves. In *dentaria* the valves open with a sudden jerk, and in *cardamin*, after opening, they roll back spirally. Sometimes the partitions are parallel to the valves, as in *draba*, and sometimes they are contrary, as in *subularica*, but always longitudinal. The cells of the silique are generally two in number, as in cheiranthus, but sometimes the valves are without partitions, and the pods consequently are celled, as in the genus isatis.

63.

Pea.

The *legume* is a dry and elongated pericarp, consisting of two valves with two opposite seams, to the one of which only the seeds are attached, as exemplified in the pea and bean. It consists, for the most part, of one cell only, as in *cathyrus;* but sometimes it consists of two cells as in astragalus, and sometimes of many, as in lotus. It is one seeded, as in *trifolium procumbens;* two seeded, as in *trifolium fragiferum;* or many seeded, as in *pisum*. Its figure is oblong, as in *ulex;* or cylindrical, as in *orobus;* or compressed, as in *hippocrassi;* or rhomboidal, as in *ononis;* or gibbous, as in *astragalus;* or spiral, as in *medicago;* or inversely heart-shaped, as in *polygala*. The substance of the legume, when ripe, is membranaceous, as in *medicago;* or leathery, as in *vicia;* or firm and woody, as in *mimosa;* sometimes the surface is smooth, at others rough. Such is the general character of the legume; but there is also a peculiar variety of it, which, though externally forming longitudinal sutures, to one of which only the seeds are attached, does not yet open longitudinally by means of two general valves, but transversely, by means of joints; each joint forming a cell that contains one seed, which is finally extricated by the opening of the individual joint when detached. This variety of the legume is regarded by Wildenow as constituting a distinct species of pericarp, designated by the name of commentum. But it is a distinction to which it seems scarcely entitled.

64.

Fir cone.

The *strobile* or *cone* is a hard and woody pericarp, consisting of the general receptacle and indurated scales of the catkin; in some cases, however, as in the larch, the scales are rather leathery than woody, and in others, as the common fir, (*pinus sylvestris,*) they are beset with tubercles. Under each scale there is lodged one or more seeds or nuts, in which the seeds are contained. The figure of the strobile is generally conical, or cylindrical, as in most species of pines, but sometimes also it is spherical, as in the cedar. In the mature state of the fruit, the scales which are now closely imbricated, cover the seeds or nuts so completely as to assume the appearance of forming only one compact whole, and thus the strobile hangs upon the tree during the whole of the winter season, protecting the inclosed seeds, but the heats of the succeeding summer have no sooner arrived, than the scales, formerly close and compact, begin to shrink and separate, detaching themselves from one another by the whole of their connected surface, and thus forming a passage for the discharge of the seeds.

When a fruit has attained its full maturity, it opens, the different parts of which it is composed separate, and the seeds which it contains burst the bands that, until now, kept them confined in the cavity in which they were developed. This action, by which the seeds are naturally dispersed over the surface of the ground, at the period when they are ripe, is called *dissemination.*

In the wild or natural state of plants, the dissemination of the seeds is the most powerful agent in the reproduction of species. In fact, were the seeds contained in a fruit not to issue in order to be dispersed over the earth and there be developed, species would cease to be reproduced, and entire races would disappear; and, as all plants have a determinate duration, a period would necessarily arrive when all would have ceased to live, and when vegetation would have for ever disappeared from the surface of the globe. The commencement of dissemination indicates the termination of life in annual plants, for, before it can take place, it is necessary that the fruit should have attained maturity, and that it should have become in some degree dried, but still this phenomenon does not take place, in annual herbaceous plants, until the period when vegetation has entirely ceased. In woody plants, dissemination always takes place during the period of rest into which they enter when their liber has become exhausted, and is no longer able to give rise to leaves or organs of fructification.

The fecundity of plants, in other words, the astonishing number of germs or seeds which they produce, is one of the causes which are most powerful in facilitating their reproduction, and in effecting their surprising multiplication. A single capsule of the white poppy has been known to contain 8000 seeds, and a single capsule of the *vanilla*, from 10 to 1500; a single stalk of *zea mays* will produce 2000 seeds; a single plant of *inule helenium*, or elicampane, 3000; and a single spike of *typha major*, or greater cat's tail, 10,000; a single plant of tobacco has been found, by calculation, to produce the almost incredible number of 360,000; and a single stalk of spleen-wort has been thought by estimation to produce at least a million of seeds. Let one imagine the regularly increasing progression of this number, merely to the tenth generation of these plants, and he will hardly conceive how the whole surface of the earth should not be covered by them. But many causes tend to neutralize, in part, the effects of this astonishing fecundity, which, by its very excess, would soon prove injurious to the reproduction of plants. In fact, all the seeds are not placed by nature in circumstances favourable to their development. Besides, numerous animals, and man himself, deriving their principal nutriment from fruits and seeds, destroy incalculable quantities of them. Various circumstances favour the natural dispersion of seeds. Some of these result from the structure of the pericarp, and others depend upon the seeds themselves. Thus, there are pericarps which open naturally with a kind of elasticity, by means of which the seeds contained by them are projected to greater or less distances. The fruits of *hura crepitans*, *dionæa muscipula*, the fraxinella, and balsamine, separate their valves rapidly, and by a kind of spring, project their seeds by this means to some distance. The fruit of *ecballium elaterium*, when ripe, separates from the peduncle which supported it, and projects its seeds with surprising rapidity through the cicatrix of its point of attachment.

The seeds of oats, when ripe, are projected from the calyx with such violence, that in a fine and dry day, in passing through a ripe field, they may be heard as then thrown out with a sudden snap. The pericarp of the *dorsiferous ferus* is furnished with a sort of peculiar elastic ring, intended, as it would appear, for the very purpose of projecting the seeds. The capsule of the cucumber, *geranium geum*, and fraxinella, discharge their seeds also when ripe, with an elastic jerk. But the pericarp of *impatiens*, which consists of one cell, with five valves, exhibits, perhaps, one of the best examples of this mode of dispersion. If it is accidentally touched when ripe, it will immediately burst open, while the valves coiling themselves up in a spiral form, and springing from the stem, discharge the contained seeds, and scatter them all around. The bursting of the pericarp of some species of pines is also worthy of notice. The cone remains in the tree till the summer succeeding that on which it was produced, the scales being still closed. But when the hot weather has commenced, and continued for some time, so as to dry the cone thoroughly, the scales open of their own accord with a sudden jerk, ejecting the contained seeds, and if a number of them happens to burst together, which is often the case, the noise is such as to be heard at some considerable distance. The twisted arm of *avena fatua*, or wild oat, as well as that particularly of *geranium cicutarium*, and some others, seems to have been intended for the purpose of aiding the further dispersion of the seed after being discharged from the plant or pericarp. This spiral arm, or spring, which is beset with a multitude of fine and minute hairs, possesses the property of contracting by means of drought, and of expanding by means of moisture. Hence, it remains of necessity in a perpetual state of contraction or dilatation, dependent upon change of weather, from which as well as from the additional aid of the fine hairs which act as so many fulcra, and cling to whatever object they meet, the seed to which it is attached is kept in continual motion till it either germinates or is destroyed. The arm of barley, which is beset with a number of minute teeth all pointing to its upper extremity, presents also similar motions. For when the seed with its arm falls from the ear, and lies flat upon the ground, it is necessarily extended in its dimensions by the moisture of the night, and contracted by the drought of the day. But as the teeth prevent it from receding in the direction of the point, it is consequently made to advance in the direction of the base of the seed, which is thus often carried to the distance of many feet from the stalk on which it grows. If any one is sceptical with regard to this motion, let him introduce an ear of barley with the seed uppermost between his coat and shirt sleeve, at the wrist, when he walks out in the morning, and by the time he has returned, he will find it has mounted to his arm pit. This journey has been effected by means of the continued motion of the arm, and consequently of the teeth of the arm acting as feet to carry it forward. It is obvious, however, that the modes of dispersion now stated, can never carry the seed to any great distance, but where distance of dispersion is required, nature is always furnished with a resource. One of the most common modes by which seeds are conveyed to a distance from their place of growth, is that of the instrumentality of animals. Many seeds are thus transported merely by their attaching themselves to the bodies of such animals as may happen

accidentally to come in contact with the plant in their search after food. The hooks or hairs with which one part or other of the fructification is often furnished, serving as the medium of attachment, and the seed being thus carried about with the animal till it is again detached by some accidental cause, and at last committed to the soil. This is exemplified in the case of *bidens* and *mysotis*, in which the hooks or prickles are attached to the seed itself; or in the case of *galium aparini*, and others, in which they are attached to the pericarp, or in the case of the thistle and burdock, in which they are attached to the general calyx. Many seeds are dispersed by animals in consequence of their pericarps being used as an article of food. This is often the case with the seeds of the drupe, as cherries, sloes, and haws, all which birds often carry away till they meet with some convenient place for devouring the pulpy pericarp, and then drop the stem into the soil. And so also fruit is dispersed that has been hoarded up for the winter, though even with the view of feeding on the seed itself, as in the case of nuts collected by squirrels, which hoards are often dispersed by some other animal. Sometimes the hoard is deposited in the ground itself, in which case part of it is generally found to take root and spring up into plants. But it has been observed that the ground squirrel often deprives the kernel of its germ before it deposits the fruit it collects, which it has been supposed to do from some peculiar instinct, as the means of preventing the germination of the seed. It has been suggested, however, that the preference thus given to the embryo arises, perhaps, from its possessing some specific flavour peculiarly agreeable to the animal's taste, and this is, perhaps, the true solution of the question. Crows have been also observed to lay up acorns and other seeds in the holes of fence posts, which being either forgot or accidentally thrust out, fall ultimately into the earth and germinate.

But sometimes the seed is even taken into the stomach of the animal, and afterwards deposited in the soil, having passed through it unhurt. This is often the case with the seed of many species of berry, such as the misletoe, which the thrush swallows, and afterwards deposits upon the boughs of such trees as it may happen to alight upon. The seeds of the *coranthus Americanus*, and other perennial plants, are said to be deposited in like manner on the branches of the *cocoloba grandiflora*, and other lofty trees; as also the seeds of *phytolacea decandria*, the berries of which are eaten by the robin, thrush, and wild pigeon. And so also the seeds of currants or roans are sometimes deposited after having been swallowed by blackbirds, or other birds, as may be seen by observing a currant bush or young roan tree, growing out of the cleft of another tree, where the seed has been left, and where there may happen to have been a little dust collected by way of soil, or where a natural graft may have been effected by the insinuation of the radicle into some chink or cleft. It seems indeed surprising that any seeds should be able to resist the heat and digestive action of the stomach of animals; but it is undoubtedly the fact. Some seeds seem even to require it. The seeds of magnolia glauca, which have been brought to this country, are said to have generally refused to vegetate till after undergoing this process, and it is known that some seeds will bear a still greater degree of heat without any injury. Spallanzani mentions some seeds that germinated after having been boiled in water, and Du Hamel gives an account of some others that germinated even after having been exposed to a degree of heat equal to 285° of Fahrenheit. In addition to the instrumentality of animals in the dispersion of the seed, may be also added the labours of man, who for purposes of utility, or of ornament, not only transfers to his native soil seeds indigenous to the most distant regions, but sows and cultivates them with care.

The agency of wind, too, is a powerful means of the dispersion of seeds. Some are fitted for this mode of dispersion from their extreme minuteness, such as those of the mosses, lichens, and fungi, which float invisibly in the air, and vegetate wherever they happen to meet with a suitable soil. Others are fitted for it by means of an attached wing, as in the case of the fir tree, and *liriodendron tulipiferum*, so that the seed, in falling from the cone or capsule, is immediately caught by the wind, and carried to a distance. Others are peculiarly fitted for it, by means of their being furnished with an agrette or down, as in the case of the dandelion, goat's beard, and thistle, as well as most plants of the class syngenesia; the down of which is so large and light in proportion to the seed it supports, that it is wafted in the most gentle breeze, and is often seen floating through the atmosphere in great abundance at the time the seed is ripe. Others are fitted for this mode of dispersion by means of the structure of their pericarp, which is also wafted along with them, as in the case of staphylea trifolia, the inflated capsule of which seems as if obviously intended thus to aid the dispersion of the contained seed, by its exposing to the wind a large and distended surface with but little weight. And so also in the case of the maple, elm, and ash, the capsules of which are furnished, like some seeds, with a membranous wing, which, when they separate from the plant, the wind immediately lays hold off and drives before it.

A further means adopted by nature for the dispersion of the seeds of vegetables, is that of the instrumentality of streams, rivers, and cur-

rents of the ocean. The mountain stream or torrent washes down to the valley the seeds which may accidentally fall into it, or which it may happen to sweep from its banks when it suddenly overflows them. The broad and majestic river winding along the extensive plain, and traversing the continents of the world, conveys to the distance of many hundred miles, seeds that may have vegetated at its source. Thus the southern shores of the Baltic are visited by seeds which grew in the interior of Germany, and the western shores of the Atlantic by seeds that have been generated in the interior of America. Even fruits indigenous to America and the West Indies, have sometimes been found to be swept along by the currents of the ocean to the western shores of Europe. The fruit of *mimosa scandens*, *dolichos pruriens*, *genlendena bonduc*, and *anacardium occidentale*, or cashew nut, have been thus known to be driven across the Atlantic, to a distance of upwards of 2000 miles; and though the fruits now adduced as examples are not such as could vegetate on the coast on which they were thrown, owing to soil and climate, yet it is to be believed that fruits may have been often thus transported to climates or countries favourable to their vegetation.

Mr Darwin thus describes the flora in Keeling islands, some of those recently formed out of the coral reefs of the Pacific. "The cocoa-nut tree, at the first glance, seems to compose the whole wood; there are, however, five or six other kinds. One of them grows to a very large size; but from the extreme softness of its wood, is useless: another sort affords excellent timber for ship building. Besides the trees, the number of plants is exceedingly limited, and consists of insignificant weeds. The collection amounts to twenty species, without reckoning a moss, lichen, and fungus. To this number two trees must be added, one of which was not in flower, and the other I only heard of. The latter is a solitary tree of its kind in the whole group, and grows near the beach, where, without doubt, the one seed was thrown up by the waves. I do not include in the above list the sugar-cane, bannana, some other vegetables, fruit trees and imported grasses. As these islands consist entirely of coral, and at one time, probably, existed as a mere water-washed reef, all the productions now living here must have been transported by the waves of the sea. In accordance with this, the flora has quite the character of a refuge for the destitute. Professor Henslow informs us, that of the twenty species nineteen belong to different genera, and these often to no less than sixteen orders. Seeds and plants from Sumatra and Java, have been driven up by the surf on the windward side of the other islands. Among these have been found the kimiri, a native of Sumatra and the peninsula of Malacca; the cocoa-nut of Balci, known by its shape and size; the dadap, which is planted by the Malays with the pepper vine, the latter intwining round its trunk, and supporting itself by the prickles of its stems; the soap tree, the castor oil plant, trunks of the sago palm, and various kinds of seeds unknown to the Malays who settled on the islands. These are all supposed to be driven on shore by the north west monsoon, from the coast of New Holland, and thence to these islands by the south-east trade wind. Sago, masses of Java teak, and yellow wood, have also been found, besides immense trees of red and white cedar, and the blue gum wood of New Holland, in a perfectly sound condition. All the hardy seeds, such as creepers, retain their germinating power; but the softer kinds, among which is the magnolia, are destroyed in the passage. Fishing canoes, apparently from Java, have at times been washed on shore. It is interesting thus to discover how numerous the seeds are, which, coming from several countries, are drifted over the wide ocean. Perhaps all the plants I brought from this island are littoral species, on the Indian islands; from the direction, however, of the winds and currents, it seems scarcely possible that they could have come here in a direct line; it has been suggested that they may have been first carried to the coast of New Holland, and drifted back again, together with the productions of that country. In this way the seeds, before germinating, must have travelled a distance of 1800, or 2400 miles. Chamesso, when describing the Radack Archipelago, situated in the central part of the western Pacific, states that 'the sea brings to these islands the seeds and fruits of many trees, most of which have not yet grown here; the greater part of these seeds appear to have not yet lost the capability of growing.' It is also said that trunks of northern firs are washed on shore, which must have been floated from an immense distance."

Uses of fruits and seeds. The fruits, and especially the seeds of many plants, contain alimentary substances possessed of the most nutritious qualities, and frequently medicines of the greatest power. The family of *Gramineæ*, including the grains and grasses, is unquestionably one of those from which man procures the most abundant supplies of food, and herbivorous animals their most usual pasture. All the civilized nations of Europe, and of the other parts of the world, make use of bread, which is prepared from the farinaceous endosperm of the wheat, the barley, and many other gramineæ. For this reason alone, had it no other claims upon our notice, this natural family of plants is one of the most interesting in the vegetable kingdom.

The pericarps of many fruits furnish food as agreeable as useful. Every one knows the economical uses to which many fleshy fruits, such

as peaches, apples, melons, strawberries, gooseberries, currants, &c., are applied. The pericarp of the olive yields the purest and most esteemed oil. Wine, so useful to man, when used in moderate quantity, is prepared of the juice obtained by pressure from the fruits of the vine, by submitting it to fermentation. Several other fruits, such as apples, pears, rowans, &c., afford fermented liquors, which supply provinces and entire nations with their ordinary drink.

In the interior of several pericarps of the family of Leguminosæ, there is found an acidulous or sweetish, but sometimes nauseating substance, which possesses laxative properties; as is observed in the cassia, the tamarind, the follicles of the senna. Dates, figs, jujubes, and dried raisins are alimentary substances which are remarkable for the great quantity of saccharine principle which they contain. The fruits of the lemon and orange-trees contain citric acid nearly in a pure state. The small berries of the buckthorn (*rhamnus catharticus*) are highly purgative.

Seeds are not less rich in nutritious principles than pericarps. Those of the cereal plants or gramineæ, and of many leguminosæ, contain a large quantity of starch, which renders them highly nutritive. The seeds of the common flax, the quince, and the psyllium, also contain a very abundant mucilaginous principle, which renders them essentially emollient. Many seeds are distinguished by possessing a highly aromatic stimulant principle. Such are those of the anise, the fennel, the coriander, and the caraway, which are named *carminative* seeds. Others, again, produce a *refrigerant* or sedative effect upon the animal economy; such as those of the calabash, the cucumber, the melon, and the water-melon. The carminative seeds all belong to the family of umbelliferæ; the refrigerant to the cucurbitaceæ. The roasted seeds of the coffee and cocoa, are used by all civilized nations. From the seeds of the almond, walnut, beech, ricinus, hemp, and poppy, an abundant oil is obtained, which possesses properties modified in each of these plants by its being mixed with other substances. The seeds of *Bixa orellana* are used for dying reddish brown.

CHAP. XVII.

OF THE SEED AND GERMINATION.

We have seen that the fruit is essentially composed of two parts, the *pericarp* and the *seed*.

The *seed* is that part of a perfect fruit which is found in the internal cavity of the pericarp, and which contains the body that is destined to reproduce a new individual. There are no naked seeds, strictly so called: in other words, none which are not covered by a pericarp. But this latter organ is sometimes so thin, or adheres so closely to the seed, that it cannot easily be distinguished at the period when the fruit is ripe, on account of their being intimately attached to each other, and confounded, although the two parts were perfectly distinct in the ovary after fecundation. Hence it is absolutely necessary to examine the structure of the ovary with attention, in order to understand the structure which the fruit is to have.

Thus in the grasses and synanthereæ, the pericarp is very thin and intimately adherent to the seed, from which it is very difficult to distinguish it. This is equally the case in many umbelliferæ, and other plants; whereas if we examine them in the ovary, these two parts are very distinct from each other.

Every seed comes from a fecundated ovule. Its essential character consists of its containing an organized body, which, on being placed in favourable circumstances, is developed and converted into an individual perfectly similar to that from which it derived its origin. This body is the *embryo*, which is therefore the essential part of the seed.

The seed is formed of two parts: 1*st*, The *episperm*, or proper integument; 2*dly*, The *kernel* contained within the episperm.

65.

a

b

The part of the seed by which it is attached to the pericarp, is named the *umbilicus* or *hilum*, represented fig. *a*, in the common wheat. It is also familiarly known as the eye of the common bean. The hilum is always marked, on the proper integument, by a kind of cicatrix or scar of greater or less extent *b*, which never occupies more than a part of its surface, and by means of which the vessels of the *trophosperm* communicate with those of the proper integument of the seed. The centre of the hilum always represents the *base* of the seed. Its *summit* is indicated by the point diametrically opposite to the hilum.

When a seed is compressed, the surface which looks to the axis of the pericarp is the *face*, and that which is directed towards the wall of the pericarp is named the *back*. The margin or *edge* of the seed is represented by the meeting of the face and back.

When the *hilum* is situated on some part of the edge of the seed, the latter is said to be *compressed*. It is *depressed*, when the hilum is placed on its face or back.

Every seed connected by its extremity with the bottom of the pericarp, or of one of its cells, when it is multilocular, and following the same direction in a more or less decided manner, is

named *erect*, as in all the *synanthereæ*. On the contrary, it is said to be *reversed* when it is attached in the same manner to the summit of the cell of the pericarp; as in the *dipsaceæ*. In these two cases, the trophosperm occupies the base or the summit of the cell.

66.

a, the episperm; *b*, the embryo, consisting, when developed, of *c*, the radicle; *d*, the gemmule; *e e*, the cotyledons or lobes.

The *episperm*, skin or proper integument of the seed, is almost always single. Sometimes, however, when it is pretty thick, and slightly fleshy in its interior, its inner wall becomes detached and separates, so that it seems to be composed of two coats, an outer, thicker, sometimes hard and solid one, to which Gœrtner has given the name of *testa*, and an inner one of less thickness, which is named the *tegmen*. This disposition is very distinctly seen in the seed of *ricinus communis;* but these two membranes are not more distinct from each other than the three parts which compose the pericarp.

The *hilum* is always situated upon the episperm. It varies in its appearance and extent. Sometimes it has the form of a hardly perceptible dot. At other times, it is very large, as in the horse-chestnut, in which its whitish colour renders it easily distinguishable from the rest of the *episperm*, which is dark-brown.

Towards the central part of the hilum, sometimes on one of its sides, there is observed a very small aperture, through which the nutritious vessels pass from the *trophosperm* into the tissue of the *episperm*. When the bundle of vessels is continued some time before it ramifies, it forms a prominent line, to which the name *raphe* has been given. The internal point at which this ends is named the *internal chalaza* or *umbilicus*. The raphe is often not easily perceptible at the outside, and only discoverable by the aid of dissection, as in many *euphorbiaceæ;* while, at other times, it is prominently and easily seen, as in the genus *citrus*, in which it extends from one end of the *episperm* to the other.

In many seeds there is observed near the hilum, often on the side next the stigma, a perforated organ, which Turpin has designated by the name of *micropyle*. Some authors are of opinion that the fecundating fluid makes its way to the young embryo through the aperture in this organ.

Mr Brown considers it as the base of the seed. The radicle of the embryo always corresponds exactly to it. Previous to fecundation, the ovule is composed of two membranes and a kernel. The outer membrane, or *testa*, has, sometimes near the hilum, sometimes at a greater or less distance from it, a small punctiform aperture, which had been noticed by some of the older observers, and to which M. Turpin gave the name of *micropyle*. This aperture has no direct communication with the walls of the ovary. According to Mr Brown, it indicates the true base of the ovule; and the point which is opposite to it, its summit. The nutritious vessels of the pericarp, which arrive at the ovule through the hilum, creep in the substance of the testa until near its summit, where they form a kind of expansion communicating with the inner membrane, and which is named the *chalaza*. This inner membrane has a direction the reverse of that of the outer, being inserted by a broadish base upon the summit of the latter, the only point at which the two membranes communicate with each other. The summit of the inner membrane is also perforated with a small aperture, exactly corresponding to that in the base of the testa. The kernel contained within the two integuments of the ovule is a cellular body, having always the same direction as the internal membrane, or, in other words, is inserted at its base, or the point opposite to its perforated summit. It consists of two parts, an outer, thick and cellular part, the *chorion* of Malpighi; and an internal part, forming a kind of small cellular sac, often filled at first with a mucilaginous fluid. This inner part is the *amnios*, and its fluid the *liquor amnii*. It is in the internal sac that the embryo begins to make its appearance. Its radicle always corresponds to the summit of the kernel, or to the aperture or base of the outer integument of the ovule. The endosperm, which often accompanies the embryo, may be formed by the sac of the amnios, or by the chorion, the amnios being absorbed, or by both organs at once.

There is sometimes observed, at a greater or less distance from the *hilum* of some seeds, a kind of inflated body, as in the date, the asparagus and commelina. During germination this body separates, and allows the embryo to pass.

The episperm is in general merely applied upon the *kernel*, from which it is easily separated; but, in some cases, it adheres so intimately that it can be removed only by scraping it off. It never has cells or partitions in its interior, its cavity being always simple, although, in some rare cases, it may contain several embryos.

The *kernel* is all that part of a ripe and perfect seed which is contained in the cavity of the episperm. It has no vascular communication with the episperm, unless when the two organs are intimately united, in which case it is difficult to determine whether they may not have some communication of this kind. The entire kernel may be formed by the *embryo*, as in the kidney-bean, the lentil, &c. In other words, the embryo exclusively fills the whole internal

cavity of the episperm. At other times, the kernel contains, together with the embryo, another body, which is named the *endosperm;* as in *ricinus communis*, the wheat, &c.

The structure of these two organs is so different, that they are easily distinguished at first sight. The *embryo* is an organized body, which is destined to become enlarged and developed by germination. The *endosperm*, on the contrary, is a mass of cellular tissue, sometimes hard and horny, at other times soft and fleshy, which, after germination, shrivels and generally diminishes in size, instead of enlarging. Thus, then, germination will remove all doubt as to the nature of the two bodies contained within the episperm, when it may not have been satisfactorily determined by analysis and dissection.

The *endosperm* is that part of the kernel which forms, around or on the side of the embryo, an accessory body, which has no continuity of vessels or of tissue with it. It is generally formed of vascular tissue, in the meshes of which is contained starch, or a thick mucilage.

This substance affords nutriment to the young embryo. Before germination, it is entirely insoluble in water; but at the first period of vegetable life it changes its nature, becomes soluble, and contributes to the nutrition and development of the embryo. It is always easy to separate the endosperm from the embryo, as they do not in the least cohere. Its colour is generally white, or whitish, though green in the misletoe and the substance of which it is formed varies greatly. Thus it is *dry* and *farinaceous*, in many gramineæ, as wheat, oats, barley. *Coriaceous*, and, as it were, *cartilaginous*, in many umbelliferæ. *Oleagenous* and *fleshy*, or thick and greasy to the touch, as in *ricinus communis*, and many other euphorbiaceæ. *Horny*, tenacious, hard, and elastic, as in the coffee and many other rubiaceæ, most of the palms, &c. *Thin* and membraneous; as in many labiatæ, &c.

The *embryo* is the already organized body, existing in a perfect seed after fecundation, and which constitutes the compound rudiment of a new plant. When placed in favourable circumstances, it is converted, by the act of germination, into a plant perfectly similar, in every respect, to that from which it derived its origin. When the embryo exists by itself in the seed, that is, when it is immediately covered by the *episperm* or proper integument, it is said to be *epispermic*, as in the kidney-bean. When, on the contrary, it is accompanied by an *endosperm*, it takes the name of *endospermic*, as in the gramineæ, *ricinus communis*.

The embryo being a plant already formed, all the parts which it is one day to develope already exist in it, but only in the rudimentary state. It is essentially composed of four parts: 1. The *radicular body;* 2. The *cotyledonary body;* 3. The *gemmule;* 4. The *caulicle*.

1. The *radicular body* or *radicle*, constitutes one of the extremities of the embryo. When germination takes place, it gives rise to the root, or forms it by its development.

In the embryo in the state of rest, that is, before germination, the radicular extremity is always simple and undivided. When it begins to be developed, it often sends off several small knobs, which constitute so many radicular filaments; as in the gramineæ. If, in some cases, it is difficult, before germination, to distinguish the radicle, it becomes easy to do so when the embryo begins to grow. Thus, the radicular body always tends towards the centre of the earth, whatever impediments may be put in its way, and changes into a root, while the other parts of the embryo take an opposite direction. In a certain number of plants, the radicular body itself elongates, and changes into a root, in consequence of the development which germination induces in it. This is what is observed in many dicotyledones.

When the radicle is external and exposed, the plants are named *exorhizous*. Of this kind are the labiatæ, cruciferæ, boragineæ, synanthereæ, &c., and the greater number of dicotyledonous plants.

In other plants, again, the radicle is covered and entirely concealed by a particular envelope which bursts at the period of germination, to allow it to escape. This body has received the name of *coleorhiza*. In this case the radicle is internal or *coleorhizous*, and the plants which present this disposition are named *endorhizous*. To this division belong most of the true monocotyledones, such as the palms, the gramineæ, liliaceæ, &c.

Lastly, in some less frequent cases, the radicle is incorporated with the endosperm. Plants in which this organization is observed, are named *synorhizous*. Of this kind are the pines, firs, and other coniferæ, the cycadeæ, &c. All the known phanerogamous or flowering plants belong to these three great classes.

The *cotyledonary body* may be simple and perfectly undivided. In this case, it is formed by a single *cotyledon*, and the embryo is named *monocotyledonous*; as in the wheat, the barley, the oat, the lily. At other times, it is formed of two bodies united base to base, which are named *cotyledons*, and the embryo is then said to be *dicotyledonous*, as in the bean, ash, elm. All plants whose embryo has a single cotyledon are named *monocotyledonous*. All those which have two cotyledons are called *dicotyledonous*.

Sometimes there are more than two cotyledons in the same embryo. Thus there are three in *cupressus pendula;* four in *pinus inops*, and *ceratophyllum demersum;* five in *pinus laricio;*

six in *taxodium distichum;* eight in *pinus strobus;* and lastly, ten and even twelve in *pinus pinea.*

It is thus seen that the number of cotyledons is not the same in all plants, and that the division into monocotyledons and dicotyledons, if strictly observed, is incapable of including all known vegetables. Besides, it not unfrequently happens, that the two cotyledons unite and adhere together, so that, at first sight, it is difficult to say whether an embryo is monocotyledonous or dicotyledonous, as, for example, in the horse-chestnut.

The cotyledons appear to be destined by nature to favour the development of the young plant, by supplying it with the first materials of its nutrition. For this purpose, the cotyledons are almost always very thick and fleshy, in plants which have no *endosperm*, whereas they are thin, and as it were leafy, in those which are furnished with that organ. These differences may easily be seen on comparing the thickness of the cotyledons in the kidney-bean and the *ricinus communis.*

At the period of germination, the cotyledons sometimes remain concealed under ground, without appearing at the surface. In this case, they bear the name of *hypogeal cotyledons*, as in the horse-chestnut. At other times they emerge

67.

a a, cotyledons, forming seminal leaves; *b*, the gemmule expanded into primordial leaves; *c*, the radicle.

from the ground, in consequence of the elongation of the neck, which separates them from the radicle. In this case, they are named *epigeal*, as in the kidney-bean and most of the dicotyledones. When the two cotyledons are epigeal, or rise above the ground, they form the two *seminal leaves.*

The *gemmule* is the simple or compound body which arises between the cotyledons, or in the very cavity of the cotyledon when the embryo has only one. It was formerly called the *plumule.* As this organ, in most cases, bears no similarity to a *feather* which it was thus supposed to resemble, but, on the other hand, always forms the first bud *(gemma)* of the young plant which is about to be developed, the name gemmule is more suitable. The *gemmule* is the rudiment of all the parts which are to be developed in the open air. It is formed of several small leaves variously folded upon themselves, which, being developed by germination, become the *primordial leaves.* Sometimes it is free, and to be seen at the exterior, previous to germination. At other times, on the contrary, it becomes apparent only when germination has commenced. Lastly, in some rare cases, it is concealed under a kind of envelope which is named *coleoptile.* This envelope of the radicle is, in most cases, to be considered only as a thin cotyledon, covering the gemmule in the manner of a sheath.

The *caulicle.* This organ is not always very obvious. It is confounded, on the one hand, with the base of the cotyledonary body, and on the other with the radicle, of which it is a kind of prolongation. It is by the growth which the caulicle acquires during germination, that the cotyledons, in some plants, are raised out of the ground.

As the monocotyledonous embryo and the dicotyledonous embryo differ greatly from each other, in the number, form, and arrangement of the parts which enter into their composition, we shall give a separate account of the characters peculiar to each.

The dicotyledonous embryo, or that which has two distinct lobes, presents the following characters: Its *radicle* is cylindrical or conical, naked, and projecting. It elongates at germination, and becomes the true root of the plant. Its two *cotyledons* are attached at the same height upon the caulicle; they have, in many cases, a thickness proportionate to the thinness of the endosperm, or its total absence. The *gemmule* is contained between the two cotyledons, which cover it, and, in a great degree, conceal it. The *caulicle* is more or less developed.

Such are the characters common to the dicotyledonous embryos in general. Some of them, however, present anomalies which might at first seem to remove them from this class. Thus the two cotyledons are sometimes so intimately united, as to look like a single one; as in the horse-chestnut, and usually in the chestnut. But it will be remarked that this union is merely accidental, for in some cases it does not take place. Besides, every embryo, the base of the cotyledonary body of which is entirely cleft, or divided into two, although it should itself appear simple and undivided at its summit, is to be considered as truly dicotyledonous.

The monocotyledonous embryo is that which, previous to germination, is perfectly undivided, and has no cleft or incision. If, in most cases,

it is easy enough to distinguish, in the dicotyledonous embryo, the different parts of which it is composed, it is not always so in the monocotyledonous embryo, in which all its parts are often so united and confounded, as to form a single mass, in which germination alone enables us to distinguish any thing. For this reason, the organization of the embryo of the monocotyledons is much less perfectly known than that of plants that have two cotyledons. In the monocotyledonous embryo, the radicular body occupies one of its extremities. It is more or less rounded, often has very little prominence, and forms a kind of indistinct papilla. At other times, on the contrary, it is extremely broad and flat, and forms the greatest part of the mass of the embryo, as in most of the gramineæ.

The *radicle* is contained in a *coleorhiza*, which it bursts at the period of germination. It is not always simple, as in the dicotyledones, but is commonly formed of several radicular filaments, which sometimes separately perforate the coleorhiza which contains them, as in the gramineæ.

The cotyledonary body is simple, and presents no incision or cleft. Its form is extremely variable, and always lateral, with respect to the total mass of the embryo. Most commonly the *gemmule* is contained in the interior of the cotyledon, which envelopes it on all sides, and forms round it a kind of *coleoptile*. It is composed of small leaves enclosing each other. The outermost usually forms a kind of sheath closed on all sides, which embraces and covers the rest. The *caulicle* does not generally exist, or is intimately confounded with the cotyledon or the radicle.

Such is the more usual organization of the monocotyledonous embryos; but, in many circumstances, there occur modifications peculiar to certain plants. Thus, for example, the family of the gramineæ presents some peculiarities in the structure of the embryo. It is composed of two parts: the first a thick fleshy body, applied upon the endosperm; the second, the *blastus*, which is the one to be developed.

The term *germination* is applied to the series of phenomena through which a seed passes, when having arrived at a state of maturity, and being placed in favourable circumstances, it swells, bursts its envelopes, and tends to develope the embryo which it contains. Before a seed can germinate, there must be a concurrence of circumstances favourable and essential to this process.

The seed must be in a state of maturity, must have been fecundated, must contain an embryo perfect in all its parts, and must not be too old, otherwise it may have lost its faculty of germination. There are seeds, however, which retain their germinating powers for a great number of years, especially those belonging to the family of leguminosæ. Thus, kidney-beans have germinated after having been kept for sixty years; and some seeds of the sensitive-plant are said to have perfectly germinated about a hundred years after they were gathered. But, before seeds that have been long kept can germinate, they must have been defended against the contact of air, light, and moisture.

The external agents which are essential to germination are water, heat, and air.

Water, as we have already seen, is indispensably necessary for producing vegetation and the phenomena of nutrition in plants. It is not merely as an alimentary substance that it acts in this case; its solvent faculty, and its fluidity, qualify it to become a menstruum and a vehicle to the substances which afford nutriment to the vegetable. In germination, its action is precisely the same. It penetrates into the substance of the seed, softens its envelopes, causes the embryo to swell, and produces changes in the nature of the endosperm or cotyledons, which often render them fitted for supplying the young plant with the first materials of its nutrition. It moreover conveys the gaseous or solid substances which are to furnish aliment to the plant which is beginning to grow. It also contributes to the development of the plant by means of the decomposition which it undergoes; its disunited elements combine with carbon, and give rise to the various principles found in plants.

The quantity of water, however, must not be too great, otherwise the seeds would undergo a kind of maceration, which would destroy their germinative faculty, and prevent their development. We here speak of the seeds of land plants, for those of aquatic vegetables germinate when entirely immersed in water. Some of the latter, however, although of such there is but a very small number, ascend to the surface to germinate there in the open air, being incapable of receiving development under water. It is therefore obvious, that water has two modes of action in germination. It softens the envelope of the seed, and renders it more easy for the embryo to burst it; and affords a solvent and a vehicle to the substances which form the aliment of the young plant.

Heat is not less essential to germination. For it exercises a very decided influence upon all the phenomena of vegetation. If a seed be put in a place, the temperature of which is under zero, it exhibits no germinative action, but remains inactive, and, as it were, torpid; whereas a gentle and regular heat greatly accelerates germination. The heat, however, must not exceed certain limits; for, if it does, instead of favouring the development of the germs, it will dry them up and destroy their vital principle. Thus a heat of from 45° to 50° of the centigrade thermometer prevents germination, while a heat not higher from 25° to 30°, especially if accompanied

by a certain degree of humidity, accelerates the evolution of the different parts of the embryo.

Air is as useful to plants, in contributing to their germination and growth, as it is necessary to animals for respiration and the general functions of life. Were a seed totally withdrawn from contact with air, it would undergo no process of development. Homberg, however, says he got some seeds to germinate in the vacuum of an air pump; but although the experiment has frequently been repeated, the same results have never been obtained. It is, therefore, certain that air is indispensably necessary for germination. Saussure, whose testimony is of such weight in the experimental part of vegetable physiology, is of opinion that Homberg's experiments cannot in the least invalidate this truth, and that the conclusions which he has drawn from them must be considered as imperfect, and possessed of little accuracy. Seeds buried too deeply in the ground, and thus withdrawn from the action of atmospheric air, have often remained for a very long time without exhibiting any sign of life; but when, by some cause, they have been brought nearer the surface of the ground, so as to come into contact with the ambient air, their germination has been effected.

As air is not a simple body, but is formed of oxygen and azote, it has been a subject of speculation whether both gases, or only one, are influential in the phenomena of germination.

The action of air upon plants, at this first period of their development, presents the same circumstances as in the respiration of animals. It is the oxygen of air that, in the act of respiration, is the principal agent in giving the blood the qualities which are to render it fitted for the development of all the organs; and the same oxygen aids and facilitates the germination of plants. Seeds placed in azotic gas or carbonic acid gas are unable to germinate, and quickly perish. We know that animals placed in similar circumstances cease to respire, and die. But it is not in a pure and separate state that oxygen produces so favourable an effect upon the evolution of the germs. In this state it accelerates germination at first, but soon puts a stop to it by the too great activity which it communicates. Accordingly, seeds, plants and animals, are unable to germinate, respire or live, in pure oxygen gas. Another substance must be mixed with it to moderate its activity, before it can be rendered fit for respiration and vegetation. It has been found that a mixture of nitrogen or azote renders it better qualified to perform this office, and that the best proportions for the mixture are one part of oxygen to three parts of azote or nitrogen.

The oxygen absorbed during germination combines with the excess of carbon which the young plant contains, and forms carbonic acid, which is expelled. By this new combination, the principles of the endosperm being no longer the same, the fecula of which it is composed, and which was insoluble before germination, becomes soluble, and is often partly absorbed, to afford the first materials of nutrition to the embryo.

Certain substances appear to have a decided influence in accelerating the germination of plants, as we learn from the experiments of Humboldt. That illustrious naturalist, to whom almost every department of human knowledge is indebted for some improvement, and many valuable suggestions, has shown that the seeds of the cultivated cress, when placed in a solution of chlorine, germinate in five or six hours; whereas, if placed in pure water, they would require thirty-six hours to attain the same state. Certain exotic seeds, which had resisted every method that had been tried to make them germinate, became perfectly developed in a solution of the same substance. He further observed, that all substances which readily yield a part of their oxygen to water, such as many metallic oxides, nitric and sulphuric acids sufficiently diluted, accelerated the evolution of seeds, but at the same time produced the effect which we have remarked as resulting from pure oxygen, that of exhausting the young embryo, and quickly destroying its vitality.

Although seeds are usually placed in earth, to germinate there, this circumstance is not absolutely necessary for their development, as we every day see seeds growing very well, and with great rapidity, in fine sponges, or other bodies which are kept soaked with water. But let it not be imagined that earth is entirely useless or unnecessary for vegetation; for the plant extracts from it, by its roots, substances which, after converting them into nutritious elements, it is enabled to assimilate.

Light, so far from accelerating the development of the organs of the embryo, retards it in an evident manner. In fact, seeds always germinate much more rapidly in darkness than when exposed to the light of the sun. All seeds do not take the same time in beginning to germinate. Thus some seeds germinate in a very short period: the cress in two days; spinach, turnips, and kidney-beans in three days; the lettuce in four; melons and gourds in five; most of the gramineæ in a week; hyssop at the end of a month; others remain for a very long period without showing signs of germination; some, and chiefly those which have the episperm very hard, or are surrounded by a woody endocarp, germinate only at the end of a year; while the seeds of the hazel, the rose, the cornel, and others, are not developed until two years after they are placed in the ground.

The first visible effect of germination is the

swelling of the seed, and the softening of the envelopes which cover it. These envelopes burst at a period which varies in different plants. The bursting of the episperm sometimes takes place in a manner quite irregular, as in the kidney-bean and common bean; while, at other times, it takes place with a uniformity and regularity which are presented by all the individuals of the same species. The latter circumstance is chiefly observed in seeds which are furnished with an *embryotegium*, a kind of operculum or lid, which separates from the episperm to allow the embryo to pass; as, for example, in the Virginian spiderwort, *Commelina communis*, *Phœnix dactylifera*, and several other monocotyledonous plants. The embryo takes the name of *plantule*, or young plant, as soon as it begins to be developed. There are then distinguished in it two extremities, which always grow in opposite directions. One of these extremities, which is formed by the gemmule, tends upwards to the region of air and light, and is named the *ascending caudex*. The other, which passes deeper into the earth, and thus follows a direction the reverse of the first, bears the name of *descending caudex*. It is formed by the radicular body. In most cases, it is the descending caudex or the radicle, that first experiences the effects of germination.

During this time, the gemmule does not remain inert and stationary. From being at first concealed between the cotyledons, it rises upwards, elongates, and proceeds in the direction of the surface of the ground, when it has been covered with earth. When the ascending caudex begins to be developed beneath the point of insertion of the cotyledons, it raises them, and carries them out of the ground. Cotyledons which exhibit this phenomenon, are then named *epigeal*.* They enlarge, sometimes even become thinner, assume a foliaceous appearance, and are then named *seminal leaves*. When, on the contrary, the ascending caudex commences above the cotyledons, the latter remain concealed in the ground, and, in place of acquiring any increase of size, diminish, wither, and at length disappear entirely. They are then named *hypogeal* cotyledons †. When the gemmule has reached the open air, the leaflets of which it is composed are unrolled, spread out, and presently acquire all the characters of leaves, the functions of which they speedily perform.

The use of the episperm, or proper covering of the seed, is to prevent the water, or other substances in which a seed germinates, from acting too directly upon the matter of which the embryo is composed. It performs, in some measure, the office of a sieve, through which only the finest *earthy* molecules can pass. Du Hamel, remarked that seeds, from which their proper integument is stripped, seldom germinate, or produce slender and deformed plants.

The endosperm, which is not always present, is nothing more than the residuum of the water contained in the cavity of the ovule, where the embryo was developed. This fluid, which Malpighi compared to the liquor amnii, when it has not been entirely absorbed during the formation and growth of the embryo, gradually acquires consistence, thickens, and at length forms a solid mass, in which the embryo is enclosed, or upon the surface of which it is merely applied. This mass is the *endosperm*. This is the reason why that body has always an inorganic aspect. Sometimes all the fluid contained in the interior of the ovule, and which has not been employed in nourishing the embryo, does not harden, part of it remaining fluid, as is exemplified in the cocoa-nut, which contains within its kernel a greater or less quantity of a kind of mild emulsion of a white colour, known by the name *cocoa-milk*.

The origin and first uses of the endosperm show of themselves the uses to which nature has intended it to be applied in germination, to supply the young plant with its first aliment. The changes which it then undergoes in its chemical composition and the nature of its elements, render it perfectly fit for this use. In some plants, however, the endosperm is so hard and compact, that it requires a long period to soften and be reduced to a more or less fluid substance, which can be absorbed by the embryo. But this phenomenon always takes place. If an embryo be deprived of, or separated from, the endosperm which accompanies it, it becomes incapable of being developed. It is therefore evident, that the endosperm is intimately connected with its growth.

The cotyledons, in many cases, appear to perform functions similar to those of the endosperm. For this reason, the celebrated naturalist Bonnet called them *vegetable mammæ*. If the two cotyledons be removed from an embryo, it fades, and ceases to receive any further development. If only one be removed, it may still vegetate, but only in a feeble and languishing manner, like a sickly and mutilated object. It is a very remarkable fact, that a dicotyledonous embryo, that of the kidney-bean, for example, may be split and separated into two lateral parts, without detriment; for, if each part contain a perfectly entire cotyledon, it will germinate as well as an entire embryo, and give rise to as strong and vigorous a plant.

The great difference of structure between the monocotyledonous and dicotyledonous embryos, has a remarkable influence upon their peculiar

* From ἐπι, upon, above, and γη, earth;—rising above the surface of the ground.

† From ὑπο, under, and γη, earth;—remaining under ground.

mode of germination. In the dicotyledonous embryo, the radicle is generally conical and protuberant; the caulicle is cylindrical; and the gemmule is naked and concealed between the bases of the two cotyledons, which are placed face to face, and are directly applied upon each other. Thus, in the kidney bean, the entire mass of the seed becomes first impregnated with

68.

a, the radicle; *b*, the gemmule; *c c*, the cotyledons; *d*, the caulicle.

humidity and swells. The episperm becomes torn in an irregular manner. Presently, the radicle, which formed a small conical prominence, begins to elongate, penetrates into the ground, and gives rise to small lateral ramifications of extreme delicacy. Soon after, the gemmule, which, until now, has remained concealed between the two cotyledons, rises upwards, and becomes apparent at the exterior. The caulicle elongates, and raises the cotyledons out of the ground, while the radicle proceeds farther into it and ramifies there. The two cotyledons then separate, and the gemmule is entirely free and uncovered; the leaflets of which it is composed spread out, enlarge, become green, and already begin to extract from the atmosphere a portion of the fluids which are to be employed in effecting the growth of the young plant. Germination is now ended, and the second period of the life of the plant commences.

Some dicotyledonous plants have a peculiar mode of germination. Thus, for example, we very often find embryos that have already germinated, in the interior of certain fruits, which are entirely closed all round. This is not unfrequently seen in the fruits of the lemon tree, in which it is not rare to find several seeds already in a germinating state. In the mangrove tree which inhabits salt marshes, and shores of the sea in the equinoxial regions, the embryo begins to be developed, while the seed is still contained in the pericarp. The radicle presses against the pericarp, which it wears, and at length perforates, and elongates at the outside, sometimes more than a foot. The embryo then becomes detached, and, leaving the cotyledonary body in the seed, falls off, the radicle first, sinks into the mud, and there continues to grow. In the horse-chestnut, the common chestnut, and some other dicotyledonous plants, the two cotyledons, which are very large and thick, are, in most cases, directly united. In these, the radicle, as it sinks into the ground, elongates the base of the two cotyledons, and thus disengages the gemmule, which shows itself above ground; but the two cotyledons are not raised by the gemmule, they remain below.

Monocotyledonous embryos generally undergo fewer changes, during germination, than those of dicotyledonous plants; which is caused by the uniformity of their internal structure. As in the dicotyledones, the radicular extremity is that which is first developed. It elongates, and its coleorhiza bursts to allow a passage to the radicular tubercle, which enlarges, and passes downwards into the ground. Several smaller roots usually spring from the lateral and inferior parts of the caulicle. When they have acquired a certain development, the principal radicle is destroyed, and disappears. Accordingly, monocotyledonous plants never have a tapering root like the dicotyledonous.

The cotyledon which contains the gemmule, always enlarges more or less before it is perforated by that organ, which generally issues at the lateral part of the cotyledon, scarcely ever at the summit. When the gemmule has perforated the cotyledon, the latter changes into a kind of sheath which embraces the gemmule at its base. It is to this sheath that the name of *coleoptile* has been given. Cut 69. fig. *a b*, represents the germination of a grain of common wheat; *c c* are the radicles; *d d* the gemmules, with their sheath. It has already been remarked that, in whatever position the seed is placed in the soil, the gemmule invariably ascends, and the radicle descends. This is a beautiful provision of nature; for had this arrangement not existed, one half of the seeds of grain sown, would have, in all probability, been unproductive; as the chances are almost equal, that the end containing the embryo falls either upwards or downwards.

69.

It now remains to consider the chemical changes which take place in the seed, during the process of germination, and regarding this a variety of opinions have been advanced. The matter contained in the cotyledons of seeds is not, in the first instance, adapted for the nourishment of the future germ; before it can become so, it must undergo certain changes in its chemical composition. It has been already shown that a seed is no sooner placed in the ground than it begins to

imbibe moisture, and swell out and burst its integuments. The moisture thus absorbed is immediately imbibed by the cotyledons or alburnum, and a chemical action soon takes place. The farina and oily matters entering into its composition, form an emulsive juice, and a fermentation takes place, by which a saccharine matter is generated, and carbonic acid gas is evolved. This process is well exemplified in the case of the conversion of barley into malt. In the barley, the starchy matter of the seed is changed from an almost tasteless and inodorous substance, into sugar; oxygen gas is absorbed, carbonic acid given out, and the greater proportion of the seed converted into a nutritious substance for the future germ.

Now, the question is, how does the absorbed oxygen operate? Does it act simply as a stimulant, or does it enter into combination with the materials of the seed, to form a new substance; or does it abstract from the seed any principle by which the subsequent changes are effected.

Humboldt was of opinion, that the oxygen acts merely as a stimulant, and this opinion was founded on the fact, that seeds germinate faster in pure oxygen, than in the common atmospheric air; and particularly if the seeds were previously steeped in water containing oxymuriatic acid. This philosopher found that seeds brought from the East and West Indies, which would not germinate at Vienna, in the usual manner, did so readily when steeped in oxymuriatic acid, even though they had been kept for upwards of twenty years.

Rollo was of opinion, that the absorbed oxygen is partly taken up by the seed, and assimulated with its substance, forming, along with the carbon of the seed, carbonic acid. His opinion was founded on the following fact, which he had observed in watching the process of the germination of some grains of barley, confined in an artificial atmosphere. When the seeds were made to germinate in pure oxygen gas, the oxygen gradually disappeared, and its place was found to be occupied by carbonic acid gas.

Saussure the younger, having also directed his attention to the subject, perceived that the only means of ascertaining the fact was, that of comparing the quantity of oxygen gas consumed, with the quantity entering into the composition of carbonic acid gas evolved. If the quantity of the former proved to be greater than that of the latter, it was to be inferred that a portion of oxygen gas had been actually assimilated to the substance of the seed. But if the two quantities proved to be constantly equal, then it was to be inferred that the oxygen gas had not been assimilated to the substance of the seed, but only employed for the purpose of abstracting from it part of its carbon, in the formation of carbonic acid gas. From the experiments of Lavoisier on combustion, he had discovered that oxygen, in combining with carbon, undergoes no perceptible alteration of volume, and that one hundred cubic inches of carbonic acid gas, contains ninety-eight cubic inches of oxygen gas. From these facts, Saussure instituted a series of experiments to ascertain the proportion between the quantity of oxygen inhaled, and the quantity of carbonic acid evolved. For this purpose he employed the seeds of peas, beans, barley, lettuce, and cress, and the results were as follows. In an atmosphere of 100 cubic inches of common air, known to contain about twenty-one cubic inches of oxygen, and seventy-nine of nitrogen, where a number of these seeds were made to germinate, it was found that if fourteen cubic inches of carbonic acid gas were formed during the process, seven cubic inches of oxygen gas remained uncombined in the atmosphere; and if seven cubic inches of carbonic acid gas were formed during the process, then fourteen cubic inches of oxygen gas remained uncombined in the receiver. Hence it appeared that the quantity of carbonic acid gas that was evolved during the process of germination, was precisely equal to the quantity that had been absorbed during the same process. There was consequently no actual accumulation of oxygen in the seed, the portion of this gas absorbed having gone to diminish the quantity of carbon. The change, therefore, produced in the farina of the seeds of plants, by which it is converted into a saccharine juice fit for the nutrition of the germ, or infant plant, consists in diminuting the proportion of its carbon, and in augmenting that of its oxygen and hydrogen. Humboldt, as we have already mentioned, found that seeds could be made to germinate in pure oxygen gas, and in a shorter period of time than in ordinary air. But Saussure, in repeating these experiments of Humboldt, did not find any difference in the periods of germination. The only difference was in the comparative lengths of the roots, those seeds which had been made to germinate in pure oxygen, having their radicles less developed in a given time, than the others in common air. This circumstance, according to Mr Keith, may be accounted for in two ways. The oxygen, in its pure state, might have abstracted too great a quantity of carbon from the seed; or the carbonic gas, evolved in too great abundance, might have been prejudicial to the development of the young plant. For it has been found that carbonic acid gas is not useful to vegetables in general, except in proportion as they can decompose it; and seeds before the development of the plumulet, do not seem capable of effecting that decomposition; so that, the application of carbonic acid, in almost any proportion, rather retards than accelerates the first process of germination. Saussure also found that different

species of seeds require different proportions of oxygen for their germination. The quantity of this gas consumed by the bean and lettuce, before the commencement of germination, seemed to be equal, and amounted to an 100th part of their weight; while the quantity consumed by wheat, barley, and purslain, which seemed also to be equal, was only about 1000th part of their weight. The carbon lost at the same time, is only about one-third part of these quantities; and the oxygen consumed is in proportion to the weight of the seeds, not in proportion to their size or number.

But Huber and Senebier detail experiments, in which certain seeds are said to have germinated in an atmosphere of pure hydrogen and nitrogen gases. In these cases, the usual carbonic acid gas being also evolved, as in ordinary germination, the question arises whence the oxygen was derived necessary to the formation of the carbonic acid. Senebier accounts for it from the decomposition of the water contained in the seed, while Saussure, doubting this theory, repeated the experiments which gave rise to it, and found that no seeds would germinate in an atmosphere of pure hydrogen, or nitrogen; and that the seeming exceptions may be accounted for from the action of the uncombined oxygen, contained in the water in which the seed had been placed, or previously steeped. Even after the process of germination has taken place, if the young plant be immersed in an atmosphere of either of those gases, vegetation and life will immediately cease. It is true that seeds immersed in water, do evolve a portion of carbonic acid, carbonated hydrogen, and nitrogen gases; but these separate from the seed during the process of fermentation, when this process is passing into that of putrefaction.

M. Rollo had observed, that during the process of germination, many seeds had their mucilage converted into sugar; but finding that this process never took place where there was no access of oxygen, and knowing that sugar contains more oxygen than mucilage, he concluded that the accession of oxygen was derived either from the atmosphere, or from the decomposition of the water in which the seeds were soaked. He ascertained that it could not be derived from the atmosphere surrounding the plant, as its elements remained the same, and therefore concluded, that it was obtained by the decomposition of water. Saussure supposed that the same facts may be established from the circumstance that the carbon of the seed suffers diminution. But finding that a certain weight of dried seeds, after germination, contained more carbon than the same weight before this process, he instituted experiments, by which he established that if any seed whatever is subjected to the germinating process, it actually loses weight, in a proportion greater than what might be allowed for its loss of carbon and mucilage during this process. Saussure attributes this circumstance to a diminution of the water formerly existing in a fixed state in the seed. A quantity of peas gathered for some years, and dried in a stove, were found to weigh 200 grains. They then underwent the germinating process, in a vessel placed over mercury, amid five times their weight of water, and an atmosphere of common air. When germination was completed, 4½ cubic inches of carbonic acid gas were found to have been produced in the receiver, which, according to Lavoisier, contains 0.85 parts of a grain of carbon. The water which was now evaporated, left as a residuum, 0.75 parts of a grain of mucilage, and extract; and the seeds which were again dried, evolved during this process, a quantity of carbon, in the form of carbonic acid, very nearly equal to the quantity lost in germination. The seeds, therefore, ought to have weighed 197½ grains; but their actual weight was only 189 grains. Now, besides the principles already mentioned, they could have lost only water, and this loss amounted to 8½ grains. It remained to be proved then, whether the loss arose in the process of germination, or in drying afterwards. The latter was the case.

Such are the phenomena, physical or chemical, observable in the germination of the seed. Air and moisture are absorbed from the soil or atmosphere; their agency is immediately exerted on the farina of the albumen or cotyledons; and a food is thus prepared for the nourishment of the tender embryo, to which it passes through the medium of the vessels of the cotyledons, or, as they have been also denominated, the seminal root. The radicle gives the first indications of life, expanding and bursting its integuments, and at length fixing itself in the soil: the plumulet next unfolds its parts, developing the rudiments of leaf, branch, and trunk; and finally the seminal leaves decay and drop off; and the embryo has been converted into a plant capable of abstracting immediately from the soil or atmosphere, the nourishment necessary to its future growth.

CHAP XVIII.

THE FOOD OF VEGETABLES.

After the embryo, as we have seen, has been converted into a plant, and after it has exhausted the store of nutritious matter prepared for it by the cotyledons, it then has to seek its future nourishment from the soil by means of its roots, and from the air by its leaves. It remains to be considered then, what are the substances which plants derive from the earth and air.

Soil is composed of certain mixtures of the following substances. The earths, silex, alumina, lime, magnesia. The alkalies, potass, soda, and ammonia, oxide of iron, and small portions of other metallic oxides, and a considerable proportion of aqueous moisture, and several gases, as oxygen, hydrogen, carbonic acid, besides the soil also contains vegetables and animal matters either partially or wholly decomposed.

The atmosphere, again, consists of oxygen, nitrogen, and carbonic acid, with a varying portion of aqueous vapour.

All these ingredients, however, are not taken up by vegetables; part only are selected, and in certain proportions. The elementary ingredients of all plants consists of carbon, oxygen, and hydrogen, in various proportions, and under various modifications. Now, most soils would yield these ingredients, and yet it is well known that certain plants only thrive in particular soils. Nor does it follow that these ingredients enter the plant in an uncombined state, because they do not actually exist in this free and uncombined state in all soils. A power of selection then is made by the plant, and this it is enabled to do by the vital powers of assimilation, by which it is endowed. We shall consider the food of plants under the six heads of water, gases, vegetable extracts, salts, earth, and manures.

Water. A certain degree of fluidity is necessary for all organised bodies before the principle of germination can be excited in a seed. It must first be moistened with water, and after the process of evolution has been completed, a regular supply of fluid is necessary to fill the cells and tubes of the growing plant. Plants will not continue to vegetate unless their roots are supplied with water; and if they are kept long without it the leaves will droop and become flaccid, and assume a withered appearance. Now this is evidently owing to the loss of fluid; for if the roots are again well supplied with water the weight of the plant is increased, and its freshness restored. But many plants will grow, and thrive, and effect the development of all their parts, if the root is merely immersed in water, though not fixed in the soil. Lilies, hyacinths, and a variety of plants with bulbous roots, may be so reared, and are often to be met with so vegetating; and many plants will also vegetate though wholly immersed. Most of the marine plants are of this description. It can scarcely be doubted, therefore, that water serves for the purpose of a vegetable aliment.

But if plants cannot be made to vegetate without water, and if they will vegetate, some, when partly immersed without the assistance of soil; and some even when totally immersed so as that no other food seems to have access to them, does it not follow that water is the sole food of plants, the soil being merely the basis on which they rest, and the receptacle of their food? This opinion has had many advocates, and the arguments and experiments adduced in support of it were at one time thought to have completely established its truth. It was indeed, the prevailing opinion of the seventeenth century, and was embraced by several philosophers even of the eighteenth century; but its ablest and most zealous advocates were Van Helmont, Boyle, Du Hamel, and Bonnet, who contended that water, by virtue of the vital energy of the plant, was sufficient to form all the different substances contained in vegetables.

Van Helmont planted a willow weighing fifty pounds, in an earthen vessel containing a known quantity of earth which had been previously dried in an oven. He moistened it with distilled water, or with rain water, and took care to prevent any accession of other earth. At the end of five years the plant was taken up and weighed. Its weight, together with that of all its leaves, was $169\frac{1}{4}$ pounds, and the weight of the earth, only two ounces less than at first, giving an accession of $119\frac{1}{4}$ pounds, which is to be accounted for only from the water with which the earth was moistened. Hence, it was concluded that water is the sole food of plants; the two ounces of earth lost being regarded as bearing too small a proportion to the increased weight of the willow to deserve any notice in the calculation.

Boyle dried a quantity of earth in an oven, which after having weighed he put into an earthen pot. He then sowed some gourd seed in the earth, and watered it with spring or rain water. A plant was ultimately produced that weighed three pounds, and in a subsequent experiment, a plant that weighed four pounds; and yet the weight of the earth, when dried and weighed again, was not perceptibly diminished. This seemed to give weight to the foregoing conclusion.

Du Hamel placed some bulbous roots merely in moss or wet sponges, and they vegetated; and beans and peas when so treated even flourished and produced fruit. Bonnet in repeating the experiments of Du Hamel had the same result, and in trying its operation upon vines, found that they produced excellent grapes. Nothing further seemed necessary to determine the point at issue, and it was accordingly believed that water is the sole food of plants, and that the other substances which they may contain are formed merely from the water, by virtue of the vital energy of the plant.

But though these experiments have the appearance of being somewhat decisive, yet there are others by the same experimenters which are not quite so favourable to the opinion they were intended to support. Du Hamel reared in the

above manner plants of the horse-chestnut and almond to some considerable size, and an oak till it was eight years old. And though he informs us that they died at last only from neglect of watering; yet it seems extremely doubtful whether they would have continued to vegetate much longer even if they had been watered ever so regularly; for he admits, in the first place, that they made less and less progress every year, and in the second place, that their roots were found to be in a very bad state.

But if they had even continued to vegetate, still the experiments were insufficient to decide the point in question. Their insufficiency was first pointed out by Bergman in 1773, who showed, from the experiments of Margraff, that in one pound of rain water there is contained one grain of earth. Earth, therefore, must have been absorbed along with the water, so that even the boasted experiment of Van Helmont, on which so much stress had been laid, amounted to nothing. For the rain-water employed in the experiment must have contained in it as much earth as could have been well expected to exist in the willow at the end of five years. And if not, then it is easy to point out an additional source of supply; for it has been shown by Hales and others, that unglazed earthen vessels when placed in the earth, will readily absorb moisture; so that, according to Mr Kirwan's remark, the earthen vessel in which the willow was planted must have absorbed moisture from the surrounding soil, impregnated with whatever substances the earth contained. The access of earth, therefore, is accounted for without the joint efforts of the water and vital energy of the plant, and no satisfactory proof alleged of the similar formation of other substances.

The subject was afterwards investigated by Hassenfratz, who saw the insufficiency of the foregoing proofs, and objected to them because no account was given of the proportions of carbon at the commencement and termination of the respective experiments. Did not the carbon of the plant increase also as well as its other ingredients? And yet the carbon could not be supposed to be formed from the water. To clear up this point he analyzed the bulbs of the hyacinth, and of several other plants, together with a number of kidney-beans, and cress-seeds, with a view to discover the quantity of carbon they contained, and consequently by calculation the quantity contained in any given weight of similar bulbs or seeds. He then made a number of each to vegetate in pure water, some within doors, and others in the open air, having first ascertained their weight. They germinated, grew up, and flowered; but produced no seed. They were afterwards gathered, leaves and all, and subjected to a chemical analysis, the result of which was, that the carbon contained in each was somewhat less than the quantity which existed in the bulb or seed from which the plant had sprung.

From these circumstances Hassenfratz came to the conclusion that water was not the sole food of plants, because plants growing in pure water receive no increase of carbon, and in consequence, without a sufficiency of this substance, cannot produce perfect seeds. Not reckoning the experiments of Hassenfratz conclusive, however, Saussure instituted others. Having gathered some plants of mint (*mentha piperita*), he found that 100 parts in weight of the green vegetable substance were reduced by drying to 40.29, which were found by experiment to contain 10.96 of charcoal. He then took a number of plants of the same species, and placed them by the roots in bottles filled with distilled water; exposing them to the sun on the outside of a window, but sheltering them from the rain. After ten weeks of vegetation the 100 parts of mint weighed in their green state 216 parts, which were reduced by drying to 62. They had augmented therefore, in dried vegetable matter 21.71 parts; but they had augmented also in their quantity of carbon; for the 62 parts of dried vegetable substance furnished 15.78 of charcoal. A similar result was obtained from a similar experiment upon beans, from which we may infer the accuracy of Saussure, and the consequent inaccuracy of Hassenfratz, who was no doubt misled by some circumstances not taken into the account. Perhaps, the plants on which he made his experiments were not sufficiently exposed to the light of the sun; so that if he corrected one error he committed also another. While it is maintained, therefore, that water is not the sole food of plants, and is not convertible into the whole of the ingredients of the vegetable substance, even with the aid of the vital energy, it must, at the same time, be admitted that plants, though vegetating merely in water, do yet augment the quantity of their carbon.

Gases. When it was found that water is insufficient to constitute the sole food of plants, recourse was next had to the assistance of the atmospheric air, and it was believed that the vital energy of the plant is at least capable of furnishing all the different ingredients of the vegetable substance, by means of decomposing and combining, in different ways, atmospheric air and water. But as this extravagant conjecture is founded on no proof, it is consequently of no value. It must be confessed, however, that atmospheric air is indispensably necessary to the health and vigour of the plant, as may be seen by looking at the different aspects of plants exposed to a free circulation of air, and plants deprived of it; the former are vigorous and luxuriant, the latter weak and stunted. It may be seen also by means of experiments even upon

a small scale. If a plant is placed under a glass to which no new supply of air has access, it soon begins to languish, and at length withers and dies; but particularly if it is placed under the exhausted receiver of an air pump, as might indeed be expected from the failure of the germination of the seed in similar circumstances. According to the experiments of Saussure, plants of peas, though completely developed and furnished with their leaves, died in the space of three days, when put into the exhausted receiver of an air-pump, whether in the shade or the sun. But plants with thick and succulent leaves seem capable of supporting vegetation *in vacuo*, at least if exposed to the sun. A plant of the *cactus opuntia*, lived more than a month in this state without showing any symptoms of decay, except that the epidermis seemed dry, which again recovered its freshness, however, in the atmospheric air. And though plants with thin leaves generally died under the experiment, yet there were exceptions even among them. A plant of the *polygonum persicaria* lived for six months in the *vacuum* of an air-pump, and was at the end of the experiment as fresh and vigorous as at the beginning, with the exception of two or three leaves near the root, which were withered. The same was the case also with plants of the *epilobium molle*, *epilobium hirsutum*, *lythrum salicaria*, and *inula dysenterica*. They were placed in the light, but not so as to receive the direct rays of the sun, to which when they were exposed they withered, even though the rays were but feeble.

In these experiments of Saussure, however, it is doubtful whether the inclosed plants did not create an atmosphere for themselves out of their superfluous moisture, in the same way as is illustrated in the recent experiments of enclosing plants in an air-tight bell glass, or glass frame, when they will continue to vegetate for years; the moisture being restrained from passing off by evaporation, and the vital energies of the plant being adequate to reproduce the gases necessary for its existence by the decomposition of water.

The gases, therefore, seem essential to vegetable existence, though we are not yet to conclude that water and the gases are the sole ingredients which are necessary for the growth and vigour of plants.

It must be admitted no doubt, that plants of slow growth and tenacious of life, such as many of the mosses, and some of the succulent plants, do indeed effect the development of their parts, without the aid of any other nourishment beyond what they derive from the atmosphere. But plants of rapid growth, such as annuals, can never effect that developement without the aid of nourishment derived from the soil. Saussure tried the experiment upon beans, peas, and cresses, by placing them in horse-hair, or in pure sand, and moistening them with distilled water. They grew indeed, and some of them even flowered, but never produced perfect seeds. It is plain, therefore, that some essential principle of nourishment was wanting, which is furnished by the soil; and that atmospheric air and water are not the only principles constituting the food of plants.

But as in germination so also in the progress of vegetation, it is part only of the component principle of the atmospheric air that are adapted to the purpose of vegetable nutrition, and selected by the plant as a food. Let us take them in the order of their reversed proportions.

Carbonic acid gas. In the process of the germination of the seed, the effect of the application of carbonic acid gas was found to be altogether prejudicial. But in the process of subsequent vegetation its application has been found, on the contrary, to be extremely beneficial. Plants will not indeed vegetate in an atmosphere of pure carbonic acid, as was first ascertained by Dr Priestley, who found that sprigs of mint growing in water, and placed over wort in a state of fermentation, generally became quite dead in the space of a day, and did not even recover when put into an atmosphere of common air.

But Dr Percival, of Manchester, observed that a plant of mint, immersed in water by the root, and exposed to a current of atmospheric air mixed with carbonic acid gas, was more vigorous and luxuriant than a plant of the same species similarly situated and exposed to a current of pure atmospheric air.

Improving upon this hint, Saussure made some experiments with a view to determine the dose of carbonic acid gas, which, being mixed with atmospheric air, is the most favourable to vegetation. Having made some peas to germinate in water till they acquired the height of four inches, and weighed about twenty grains, he then placed a number of them in glasses filled with water by threes, so as that the roots only were immersed, and introduced them into receivers filled with different mixtures of common air and carbonic acid gas. They were situated so as to receive the direct rays of the sun, moderated when too intense. The mean augmentation in weight of such as were placed in pure atmospheric air, and exposed during ten days to the sun, was eight grains to each plant. Such as were exposed to the sun, in an atmosphere of pure carbonic acid gas, faded and withered away without any further development. In an atmosphere containing three-fourths or two-thirds of its volume of carbonic acid gas, they withered also; but in an atmosphere containing only one half of its volume of carbonic acid they lived seven days. And in an

atmosphere containing but one-fourth of its volume of the same gas, they lived ten days, and augmented their weight by five grains. Lastly, the mean augmentation in weight of such as were placed in an atmosphere of common air, containing one-twelfth part of carbonic acid gas, was eleven grains. This experiment was repeated frequently, and was found to yield a uniform result; the plants always succeeding better than in pure atmospheric air. Carbonic acid gas, therefore, is of great utility to the growth of plants vegetating in the sun, as applied to the leaves and branches, and whatever increases the proportion of this gas in their atmosphere, at least within a given degree, forwards vegetation.

But the result was not the same when the plant was placed in the shade; the smallest dose of carbonic acid gas, in addition to that of the atmospheric air, being then prejudicial to vegetation. This appears from the following experiments: Plants kept in the shade, and placed in an atmosphere containing one-fourth of its volume of carbonic acid gas, died on the sixth day; and when the atmosphere contained only one-twelfth of its volume of this gas, they lived indeed ten days, but weighed only three grains, while those in pure atmospheric air weighed five grains. Carbonic acid gas, therefore, as applied to the leaves and branches of plants, is prejudicial to their vegetation in the shade, if administered in a proportion beyond that in which it exists in atmospheric air. This may be readily accounted for from the now ascertained modes in which plants feed and respire.

In the shade, plants absorb oxygen, and throw out carbonic acid gas, or perform a function nearly allied to the respiration of animals. In sunshine they absorb carbonic acid, and give out oxygen, or perform an action somewhat analogous to digestion.

But carbonic acid gas is also beneficial to the growth of the plant, when applied to the root. This Saussure ascertained by experiment also. Two boards, pierced with a number of holes, were made to float in two vessels filled, one with distilled water, and the other with water impregnated with carbonic acid gas. On each of these boards was placed a number of peas that had been lately made to germinate in distilled water. Their radicles at the commencement of the experiment were two lines and a half long. At the end of ten days, the roots in contact with the distilled water were longer by five inches, than those in contact with the acidulated water; and the stalks and leaves were developed in the same proportion. But at the end of a month the plants vegetating in the acidulated water, had acquired the same dimensions as the others, and at the end of six weeks had considerably surpassed them. It follows, therefore, that carbonic acid gas as applied to the roots of plants, is also beneficial to their growth, at least, in the more advanced stages of vegetation.

Oxygen. As oxygen is essential to the commencement and progress of germination; so also it is essential to the progress of vegetation. This is clearly proved by the following experiments of Saussure: Having pulled up some young plants of the horse-chestnut, furnished with their leaves, and weighing about 460 grains, he introduced their roots, which were nearly a foot in length, into receivers of about sixty cubic inches in capacity, and luted the base of the stem to the neck of the receiver. Into one of the receivers, each of which contained a quantity of distilled water, he introduced twenty-eight cubic inches of nitrogen, which was in contact with the upper part of the root, while the under part was immersed in water. Into another he introduced an equal quantity of hydrogen; and into a third an equal quantity of carbonic acid. The plant, whose root was in contact with the carbonic acid, died in the course of eight days: the others lived a fortnight, but had not diminished the volume of their atmosphere. But plants which were placed at the same time in a similar apparatus, furnished with atmospheric air, gave a very different result; for at the end of three weeks, when the experiment was stopped, they were still fresh and vigorous, and the volume of their atmosphere was diminished. It is obvious, then, that the presence of oxygen is beneficial to the growth of the vegetable, at least, as applied to the root; because that is the only principle which had access to the root in the last experiment, which had not access to it in the former.

But oxygen is beneficial to vegetation, as applied also to the other parts of the plant as well as to the root. Branches of woody plants taken in the spring, immediately before the expansion of the bud, and enclosed in receivers filled with common air, together with a small quantity of water to supply them with moisture, developed their leaves as if attached to the parent plant. And this development was effected solely by means of the oxygen contained in the receiver; for in mediums deprived of oxygen, no development took place. The presence of oxygen, therefore, is necessary to the development of the leaves.

But it is necessary also to the development of the flower and fruit. The flower-bud will not expand if confined in an atmosphere deprived of oxygen; nor will the fruit ripen. Flower buds confined in an atmosphere of pure nitrogen, faded without expanding. A bunch of unripe grapes introduced into a globe of glass, which was luted by its orifice to the bough, and exposed to the sun, ripened without effecting any material alteration in its atmosphere. But when a bunch was placed in

the same circumstance, with the addition of a quantity of lime, the atmosphere was contaminated, and the grapes did not ripen. Oxygen, therefore, is essential to the development of the vegetating plant; and for this purpose it is absorbed by the stomata of the leaves.

Saussure having suspended a plant of the *cactus opuntia*, after sunset, in a receiver containing forty-eight cubic inches of atmospheric air deprived of its carbonic acid, but of which six cubic inches were displaced by the leaves, found early next morning, after making the necessary corrections relative to change of temperature and pressure, that the atmosphere of the plant had diminished in volume four cubic inches. The remaining air when examined, contained but $\frac{14}{100}$ of oxygen, though before the introduction of the *cactus*, it had contained $\frac{21}{100}$ of the same gas. It follows, therefore, that the diminution of quantity had affected the oxygen only. But the oxygen did not exist in the atmosphere of the plant under any combination whatever; for the application of lime water gave no indications of the presence of carbonic acid. The oxygen of the atmosphere, therefore, must have been abstracted by the leaves of the *cactus*. From which it also follows, that the leaves of vegetating plants do actually inhale oxygen, at least in course of the night.

Similar experiments on vegetating plants gave similar results, but the quantity of oxygen abstracted, was not always in the same proportion. In the present case it was very considerable, amounting to three-fourths of the volume of the leaves, while in other cases, it was often not more than one-half of their volume.

Nitrogen. Though nitrogen gas constitutes by far the greater part of the mass of atmospheric air, it does not seem capable of affording nutriment to plants; for as seeds will not germinate in it, so neither will plants vegetate. It was regarded, however, as constituting a vegetable food by some of the earlier pneumatic chemists, particularly by Priestley, who found, as it seems, that some sprigs of mint on which he had made the experiment, vegetated better in phlogisticated air than in either dephlogisticated or common air; and hence, he inferred that phlogisticated air, the nitrogen of modern chemists, serves as a vegetable food. In this opinion he was followed by Ingenhoutz, whose experiments appear to have given a similar result; contradicted, however, by the result of the experiments of Senebier, Woodhouse, and Saussure, on the same subject.

Branches of poplar, (*populus nigra*,) and willow, (*salix alba*,) whose leaf-buds were just ready to open, were introduced by Saussure into an atmosphere of nitrogen both in the shade and sun. They effected no farther development of parts, but were found to be in a state of putrefaction, after a period of five days; but in an atmosphere of common air they readily effected their development, and continued to vegetate for many weeks. Roses and lilies gathered two or three hours before their expansion, and treated in the same manner, gave similar results.

It must be admitted, however, that many plants will continue to vegetate for a time in an atmosphere of nitrogen gas, when their leaves have been previously developed; but they are such plants only as present a great extent of surface, and consume but little oxygen in the shade. A plant of the *cactus opuntia*, nourished with water, and placed in an atmosphere of nitrogen gas exposed to the influence of the sun, was found capable of supporting vegetation for the space of three weeks; but it was greatly injured by the experiment, and in the shade it lived only five days. A plant of the *sedum tellephium* when treated in the above manner, gave a similar result; and yet these plants vegetated to an indefinite time in an atmosphere of common air.

From the above experiments, it seems to follow that nitrogen gas, at least in its pure state, is unfavourable to vegetation; but particularly in the shade. And yet there are some plants that seem to succeed equally well in an atmosphere of nitrogen gas, as in an atmosphere of common air. A plant of the *lythrum salicaria*, selected for the purpose of experiment, was put into a receiver containing sixty-five cubic inches of nitrogen gas, of which it displaced about one-eighth of a cubic inch. It had its roots immersed in about an ounce of water, and was exposed to the rays of the sun, when it grew and became so luxuriant, that it was more than once necessary to remove it into a larger receiver. But this luxuriance of growth seems incompatible with the previous conclusion. At the end of two months, however, when the experiment was stopped, the receiver was found to contain the same quantity of nitrogen gas as at the beginning. The plant could have derived no nutriment, therefore, from its atmosphere. But this was the case also in all of the preceding examples. There was no diminution in the original quantity of nitrogen introduced into the receiver. It follows, therefore, that nitrogen gas, at least in its pure state, is not only incapable of affording a vegetable aliment, but is not even absorbed into the plant. But nitrogen is found in almost all vegetables, particularly in the wood, in extract, and in their green parts. It is probable, therefore, that their nitrogen is derived from the extractive principle of vegetable mould.

Hydrogen gas. A plant of the *epilobium hirsutum*, which was confined by Priestley in a receiver filled with inflammable air or hydrogen, consumed one-third of its atmosphere, and was still green. Hence Priestley inferred that it serves as a vegetable food, and constitutes even

the true and proper pabulum of the plant. But the experiments of later phytologists, do not at all countenance this opinion. Saussure introduced a plant of the *lythrum salicaria*, into a receiver containing sixty cubic inches of hydrogen gas, and exposed it to the sun. Its vegetation was perhaps somewhat more vigorous than that of plants confined in an atmosphere of nitrogen; but it had abstracted no nourishment from its atmosphere, nor effected any material change upon it. For at the end of five weeks of experiment, when its atmosphere was fired by the electric spark along with the proper quantity of oxygen, the result was the formation of water. The volume of its atmosphere was indeed diminished during the period of its vegetation; but this is to be accounted for by another cause, as will appear in the course of tracing the progress of vegetation.

The conclusion, therefore, must be, that hydrogen is unfavourable to vegetation, and does not serve as the food of plants. But hydrogen is contained in plants, as is evident from their analysis; and if they refuse it when presented to them in a gaseous state, in what state do they then acquire it? To this question it is sufficient for the present to reply, that if plants do not acquire their hydrogen in the state of gas, they may at least acquire it in the state of water, which is indisputably a vegetable food, and of which hydrogen constitutes one of the component parts.

Carbonic oxide. When plants were confined by Saussure in atmospheres of carbonic oxide, they required nearly the same condition to support vegetation, and exhibited nearly the same phenomena as in nitrogen. Such as were deprived of their green parts died in the course of a few days. The vegetation of peas whose leaves were completely developed, was languid in the sun, and did not succeed at all in the shade. The *epilobium hirsutum*, *lythrum salicaria*, and *polygonum persicaria*, vegetated indeed, as in common air; but at the end of six weeks of experiment, they had neither decomposed the oxide constituting their atmosphere, nor diminished its quantity. It cannot, therefore, be regarded as favourable to vegetation.

Vegetable extract. All vegetables, after they have flourished their allotted time, at last suffer decay, and moulder into the elements, out of which they were originally formed. In this process of decay, part of their substance escapes as gaseous matter, and part returns to the earth. This latter part has been called vegetable mould, and consists of carbon, tannin, or vegetable extract, and a portion of the earths and alkalies. Without a certain portion of this vegetable extract, no soil is fit for the nourishment of the higher classes of vegetation; although some lichens, and other cryptogamic plants, will grow from the bare and barren rock, or in pure sand. It has become a question in what manner those saline and earthy particles are taken up by plants, and whether it is necessary that the substance absorbed, should be either in a gaseous state, or in solution in water. To determine this, Saussure filled a large vessel with pure mould of turf, and moistened it with distilled or rain water, till it was saturated. At the end of five days, when it was subjected to the action of the press, 10,000 parts in weight of the expressed and filtered fluid, yielded by evaporation to dryness 26 parts of extract. In a similar experiment upon the mould of a kitchen-garden which had been manured with dung, 10,000 parts of fluid yielded 10 of extract. And in a similar experiment upon mould taken from a well cultivated corn field, 10,000 parts of fluid yielded 4 parts of extract. Such was the result in these particular cases.

But the quantity of extract that may be separated from pure mould formed by nature upon the surface of the globe, is not, in general, very considerable. After 12 decoctions, all that could be separated from mould of this sort, was about $\frac{1}{11}$ of its weight; and yet this seems to be more than sufficient for the purposes of vegetation: for a mould containing this quantity was found by experiment to be less fertile, at least for peas and beans, than a mould that contained only one half or two thirds the quantity.

But if the quantity of extract must not be too much, neither must it be too little. Plants that were put to vegetate in mould deprived of its extract, as far as repeated decoctions could deprive it, were found to be much less vigorous and luxuriant than plants vegetating in mould not deprived of its extract: and yet the only perceptible difference between them is, that the former can imbibe and retain a much greater quantity of water than the latter.

From this last experiment, as well as from the great proportion in which it exists in the living plant, it evidently follows that extract constitutes a vegetable food. But extract contains nitrogen; for it yields, by distillation, a fluid impregnated with ammonia. The difficulty, therefore, of accounting for the introduction of nitrogen into the vegetating plant, as well as for its existence in the mature vegetable substance, is done away; for although the plant refuses it when presented in a gaseous state, it is plain that it must admit it along with the extract.

But it seems also probable, that a small quantity of carbonic acid gas enters the plant along with the extractive principle, as it is known to contain this gas also. The mould analysed by Saussure, was quite dry before the commencement of the experiment, and the water employed to moisten it contained no carbonic acid. But the solution contained some; for when it was

mixed with lime-water, carbonate of lime was precipitated, though not in a quantity much exceeding that of its precipitation by spring-water in general. 100 cubic inches of the solution yielded by experiment an air containing two cubic inches of carbonic acid gas. This is, no doubt, a small proportion: but it appears from a variety of considerations, that the quantity of this gas taken up by the roots of plants is not great; consequently they do not require a great supply from the soil.

Salts. On analysing vegetable substances, certain proportions of saline matters are found in their composition, such as the nitrate, muriate, and sulphates of potash and soda. Now it may either be that the assimilating powers of vegetables, are such as to form these substances out of their primary elements, derived from the soil and atmosphere; or, that these saline matters, in a state of solution, are absorbed from the soil. Perhaps in the economy of plants, both these processes are adopted. Facts are not wanting to show that plants do absorb by their roots considerable quantities of salts in solution. M. Saussure prepared 10 different solutions, consisting each of 40 cubic inches of distilled water, together with 12 grains of the peculiar salt or other substance on which the experiment of absorption was to be made. The first solution contained muriate of potash; the second, muriate of soda; the third, muriate of lime; the fourth, sulphate of soda; the fifth, muriate of ammonia; the sixth, acetate of lime, the seventh, sulphate of copper; the eighth, crystallized sugar; the tenth, vegetable extract. Plants of *polygonum persicaria*, and *bidens cannabina*, were then immersed in each of these solutions with the following result:—In the solutions of muriate of potash, muriate of soda, sulphate of soda, nitrate of lime, and extract, the former species vegetated in the shade for five weeks, developing their parts; but in the other solutions, they died in the course of a few days. The latter species succeeded or failed in nearly the same way. It was afterwards found that a portion of the salts had been taken up along with the water by which they were held in solution; and if we suppose the quantity contained in each of the solutions to be divided into 100 parts, the ratio of their absorption may be shown as follows:—In consuming one half of the water assigned to the experiment, plants of the *polygonum* had absorbed 14 parts of muriate of potash, 13 of muriate of soda, 4 of nitrate of lime, 14 of sulphate of soda, 12 of muriate of ammonia, 8 of acetate of lime, 47 of sulphate of copper, 9 of gum, 27 of sugar, and 5 of extract. Plants of the *bidens* had absorbed the several salts in proportions not very different. But without minutely regarding proportions, the fact is thus clearly ascertained that plants are capable of taking up salts by the root, at least when presented to them in a state of artificial solution; and if so, there is then reason to presume that salts are also taken up by the roots of plants vegetating even in their natural habitats.

But if salts are thus taken up by the root of the vegetating plant, does it appear that they are taken up as a food? Some plants, it must be confessed, are injured by the application of salts, as is evident from the experiments of Saussure; but others are as evidently benefited by it. Trefoil and Lucern have their growth much accelerated by the application of sulphate of lime, though many other plants are not at all influenced by its action. The *parietaria*, nettle, and borge, will not thrive except in such soils as contain nitrate of lime, or nitrate of potash: and plants inhabiting the sea coast, as was observed by Du Hamel, will not thrive in a soil that does not contain muriatic of soda.

It has been thought, however, says Dr Keith, that the salts are not actually taken up by the root, though converted to purposes of utility, by acting as astringents or corrosives, in stopping up the orifices of the vessels of the plant, and preventing the admission of too much water: but it is to be recollected that the salts in question are found by analysis in the very substance of the plant, and must consequently have entered in solution. It has been also thought that salts are favourable to vegetation only in proportion as they hasten the putrefaction of vegetable substances contained in the soil, or attract the humidity of the atmosphere. But sulphate of lime is not deliquescent; and if its action consist merely in accelerating putrefaction, why is its beneficial effect confined but to a small number of plants?

Lastly, some writers have contended that the salts which are found in vegetables, are merely accidental in their occurrence, and not necessary to the health or perfection of the individual; because they are found to exist in but a very small proportion, both in the soil and plant: but as there are many species in which some salts are to be met with constantly and uniformly, at least, if they have vegetated in a soil in which they are found to thrive, we can scarcely regard their occurrence as being merely accidental, or, as producing no beneficial effect upon the plant. But the proportion of salts lodged in the soil is not so small as is generally believed. Re-agents do not indeed detect a great quantity in general; but that is because the alkaline salts of mould, like the alkaline salts of vegetables, are to be discovered chiefly in the remains of combustion; and because the ashes of the greater part of vegetable moulds do not readily part with their salts in boiling water. This difficulty of solution is thought by Saussure to be owing to a semivitrifaction that takes place in the mould

when the ashes are abundant. An 100 parts of mould furnished by combustion 50 parts of ashes which did not give out their salts to boiling water. But 100 parts only of dried extract from the same mould, yielded only 14 parts of ashes; and 100 parts of the ashes formed with boiling water, a ley which contained 25 parts composed of potash in an uncombined state, and of alkaline sulphates and muriates; and yet, upon further analysis, it was found that the water had not extracted more than one half of the salts which the ashes contained. The soil, therefore, contains an abundant supply of salts for all the purposes of vegetation. It may even in some cases, contain too much; for it is to be recollected that saline substances are beneficial to vegetation only when applied in very small quantities. If they are administered in great abundance they destroy the plant.

And the argument against their utility that has been drawn from the small proportion in which they are found to exist in the plant itself, is altogether inadmissible; because it is very well known that some particular ingredient may be essential to the composition of a body, and yet constitute but a very small proportion of its mass. Atmospheric air contains only about one part in the 100th of carbonic acid; and yet no one will venture to affirm that carbonic acid gas is merely an adventitious and accidental element, existing by chance, in the air of the atmosphere, and not an essential ingredient in its composition. Phosphate of lime constitutes but a very small proportion of animal bodies, perhaps not one part in 500; and yet no one doubts that it is essential to the composition of the bones. But the same salt is found in the ashes of all vegetables; and who will say that it is not essential to their perfection?

Earths. As most plants have been found by analysis to contain a portion of alkaline or earthy salts, so most plants have been found to contain also a portion of earths: and as the two substances are so nearly related, and so foreign in their character to vegetable substances in general, the same inquiry has consequently been made with regard to their origin. Whence are the earths derived that have been found to exist in plants?

It seems to have been the opinion of Lampadius, that the earths contained in plants are merely the effect of vegetation, and altogether independent of the soil in which they grow: and extravagant as the opinion is, it has been made to assume the semblance of resting upon experiment. Lampadius prepared, in his garden, five small beds of four feet square in surface by one in depth; each bed consisted of a pure earth mixed with eight pounds of cow-dung. The earths were alumine, silica, lime, magnesia, and garden mould. They were sown with rye, and the produce of each was separately reduced to ashes. But the same principles were found in them all; amongst which was a portion of silica; whence Lampadius concluded, that the silica found in plants is merely the result of vegetation, having no relation whatever to the soil in which the plants grow.

But this conclusion was by much too hasty, and has been since shown to be most palpably erroneous; because Lampadius does not take into the calculation the constituent principles of the cow-dung with which his earths were mixed, the very substance from which his plants must have derived the greater part of their nourishment. If this precaution had been taken, his conclusion must have been very different: for it has been ascertained by Ruckert, that dung does actually contain a portion of silica; which, in the case of cow-dung, will appear the less surprising if it is only recollected that the plants which cows principally feed on, do themselves contain a portion of silica. To the cow-dung, therefore, with which the different earths were manured, the origin of silica may be traced. It was thus of necessity found in them all, though not perhaps in an equal proportion.

Saussure, in adverting to the experiment of Lampadius, exposes indeed, the absurdity of his conclusion; but deduces from it another which is perhaps equally exceptionable, namely, that plants growing in calcareous and granitic sand, mixed with the same manure or mould, will produce equal quantities of ashes. But this supposes manures to have the same action upon all soils, which is surely not the fact: and if there be any manure that acts on a calcareous soil, without acting at all on a granitic soil, then the quantity of ashes will be altered in the former case, from that very circumstance; because the plant is now nourished not only by the manure that was committed to the soil, but from the original soil itself, in its state of combination with the manure.

The Berlin academy proposed as a prize question, "to determine the earthy constituents of the different kinds of corn, and to ascertain whether these earthy parts are formed by the process of vegetation. The prize was gained by Schrader of Berlin. He analyzed the seeds of wheat, rye, barley, and oats, and ascertained the portion of earth which each contains. He analyzed, in the same manner, rye straw; and having in this way ascertained the proportion of earth which these seeds contained, he endeavoured to make them grow in some medium, which could not furnish any earthy ingredient whatever. For a long time his attempts were baffled; every substance tried containing less or more of earth, and being therefore improper. At last he found that flowers of sulphur might be used with

success, as it contained no earthy matter whatever, and as the seeds grew in it, and sent out their roots perfectly well when it was properly moistened with water. The oxides of antimony and zinc were the substances which answered best after sulphur. The seeds, then, were planted in sulphur, placed in a garden at a distance from all dust, put into a box to which the light and air had free access; but from which all dust and rain were carefully excluded, and they were watered with distilled water. The corn raised in this manner, was found by Schrader to contain more earthy matter than had existed in the seeds from which it had grown. Here then, it would appear, was the formation of earthy matter, unless we conceive that the air might have contained a sufficient quantity floating in it, to furnish all that was found. Subsequently Schrader has given to the public additional experiments on the same subject. In these, he notices the trials of Saussure, and the results which were obtained from vegetables growing in calcareous and granitic soils, and particularly draws the attention of chemists to the fact ascertained by Saussure, that plants vegetating in a calcareous soil, which contained little or no silica, were yet found to yield a considerable portion of that earth. Einhof likewise found in the ashes of the common fir, which had grown in a soil that yielded no traces of lime, no less than 65 per cent of that earth.

If the earths, then, that are contained in vegetables, are derived chiefly from the soil, in what peculiar state of combination do they enter the vessels of the plant? The state most likely to facilitate their absorption, is that of their solution in water, in which all the earths hitherto found in plants are known to be in a slight degree soluble.

Lime is soluble in water with the aid of a little carbonic acid, in the proportion of about $\frac{1}{600}$ part of its weight; but it is also soluble even without the aid of the acid, and the solution is known by the name of lime-water. Clay is soluble in water by means of the mineral acids; and also, though very sparingly, in pure water, from which even the filtre cannot abstract it. Silica is soluble in water by means of carbonate of potash, as is evident from Black's analysis of the waters of Geyser in Iceland. It is soluble also in pure water, according to the analysis of Klaproth; and in that state of division in which it is precipitated from its solution in fixed alkalies, it is perfectly soluble in 1000 parts of water. Magnesia is soluble in water by means of the mineral acids, and even in pure water, in very small quantities; requiring about 2000 times its weight to hold it in solution.

All the earths, then, found in plants, are less or more soluble in water. And if it be said that the proportion in which they are soluble is so very small, that it scarcely deserves to be taken into the account, it is to be recollected that the quantity of water absorbed by the plant is great, while that of the earth necessary to its health is but little, so that it may easily be acquired in the progress of vegetation.

Such is the manner in which their absorption seems practicable: but the following experiments afford a presumption that they are actually absorbed by the root. Woodward took three plants of spearmint, one of which he made to vegetate in distilled or pure water; another in river water; and a third in water mixed with mould. At the commencement of the experiment the first plant weighed 114 grains; at the end of the experiment it weighed 155 grains, being augmented by 41 grains. The water expended was 8863 grains, and the increase as 1.214 +. At the commencement of the experiment, the second plant weighed 28 grains, at the end 54 grains, being augmented by 26 grains. The water expended was 2493 grains, and the increase as 1 : 95 +. At the commencement of the experiment the third plant weighed 92 grains, at the end 376 grains, being augmented by 284 grains. The water expended was 14950 grains, and the increase as 1 : 52 +.

From the greater proportional augmentation of the plant to which the mould had access, we may infer the beneficial effect of the earths as applied to the root, and perhaps the absorption of a part; particularly as it is known that the proportion of earths contained in the ashes of vegetables, depends upon the nature of the soil in which they grow. The ashes of leaves of the *rhododendron ferrugineum*, growing on Mount Jura, a calcareous mount, yielded 43.25 parts of earthy carbonate, and only 0.75 of silica. But the ashes of leaves of the same plant, growing on Mount Brevin, a granitic mountain, yielded two parts of silica, and only 16.75 of earthy carbonate.

It is probable, however, that plants are not indebted merely to the soil for the earthy particles which they may contain. They may acquire them partly from the atmosphere. Margray has shown that rain water contains silica, in the proportion of a grain to a pound; which, if it should not reach the root, may possibly be absorbed along with the water that adheres to the leaves.

But although the earths are thus to be regarded as constituting a small proportion of vegetable food, they are not of themselves sufficient to support the plant, even with the assistance of water. Giobert mixed together lime, alumine, silica, and magnesia, in such proportions as are generally to be met with in fertile soils, and moistened them with water. Several different grains were then sown in this artificial soil, which germinated indeed, but did not thrive;

and perished when the nourishment of the cotyledons was exhausted. It is plain, therefore, that the earths, though beneficial to the growth of some vegetables, and perhaps necessary to the health of others, are by no means capable of affording any considerable degree of nourishment to the plant.

Manures. In the preceding pages has been given a brief view of the different species of vegetable food, whether it be regarded as derived from the soil or the atmosphere. It now remains to show how the food necessary to the support of the vegetating plant may be supplied when defective, or restored when exhausted: but this unavoidably involves the subject of manures, or artificial preparations of vegetable food, so important to the advancement of agriculture, and consequent interest of mankind.

With regard to the food of plants derived from the atmosphere, the supply is pretty regular; at least, in as far as the gases are concerned; for they are not found to vary materially in their proportions on any part of the surface of the globe: but the quantity of moisture contained in the atmosphere is continually varying, so that in the same season you have not always the same quantity, though, in the course of the year, the deficiency is perhaps made up. From the atmosphere, therefore, there is a regular supply of vegetable food kept up by nature for the support of vegetable life, independent of the aid of man: and if human aid were even wanted, it does not appear that it could be of much avail.

But this is by no means the case with regard to soils; for if soils are less regular in their composition, they are at least more within the reach of human management. We have already seen the materials of which soils are composed: but what are the proportions of the materials in soils best suited for culture? According to the analysis of Bergman, the soil best suited for culture contains four parts of clay, three of sand, two of calcareous earth, and one of magnesia: and, according to the analysis of Fourcroy and Hassenbratz, 9216 parts of fertile soil contained 305 parts of carbon, together with 279 parts of oil; of which, according to the calculations of Lavoisier, 220 parts may be regarded as carbon: so that the whole of the carbon contained in the soil in question, may be estimated at about 525 parts, exclusive of the roots of vegetable, or to about $\frac{1}{18}$ of its weight.

According to Mr Young, equal weights of different soils, when dried and reduced to powder, yielded by distillation quantities of air somewhat corresponding to the ratio of their values. The air was a mixture of fixed and inflammable airs, proceeding probably from decomposition of the water; but partly, perhaps, from its capacity of abstracting a portion of air from the atmosphere, which the soil at least is capable of doing.

The following is the analysis of a fertile soil, as occurring in the neighbourhood of Bristol. In 400 grains, there were of

Water	52
Silicious sand	240
Vegetable fibre	5
——— extract	3
Alumine	48
Magnesia	2
Oxide of iron	14
Calcareous earth	30
Loss	6
Total	400

But Mr Kirwin has shown in his Geological Essays, that the fertility of a soil depends in a great measure upon its capacity for retaining water; and if so, soils containing the same ingredients must be also equally fertile, all other circumstances being the same; though it is plain that their actual fertility will depend ultimately upon the quantity of rain that falls, because the quantity suited to a wet soil cannot be the same that is suited to a dry soil. And hence it often happens that the ingredients of the soil do not correspond to the character of the climate. Silica exists in the soil under the modification of sand, and alumine under the modification of clay. But the one or the other is often to be met with in excess or defect. Soils in which the sand preponderates retain the least moisture; and soils in which the clay preponderates retain the most; the former are dry soils; the latter are wet soils. But it may happen that neither of them is sufficiently favourable to culture; in which case, their peculiar defect or excess must be supplied or retrenched, before they can be brought to a state of fertility.

But soils in a state of culture, though consisting originally of the due proportion of ingredients, may yet become exhausted of the principle of fertility by means of too frequent cropping, whether by repetition or rotation of the same, or of different crops. And in this case, it should be the object of the phytologist, as well as of the practical cultivator, to ascertain by what means fertility is to be restored to an exhausted soil; or communicated to a new one.

In the breaking up of new soils, if the ground has been wet or marshy, as is frequently the case, it is often sufficient to prepare it merely by means of draining off the superfluous and stagnant water, and of paring and burning the turf upon the surface. This mode of preparation is at present much practised throughout England, but particularly in Yorkshire and Lincolnshire, as being the best suited to the character of the soil of these counties that remains to be taken into cultivation.

If the soil has been exhausted by too frequent a repetition of the same crop, it often happens

that a change of crop will answer the purpose of the cultivator; for although a soil may be exhausted for one sort of grain, it does not necessarily follow that it is also exhausted for another. And, accordingly, the practice of the farmer is to sow his crops in rotation, having in the same field a crop, perhaps, of wheat, barley, beans, and tares in succession; each species selecting in its turn some peculiar nutriment, or requiring, perhaps, a smaller supply than the crop that has preceded it. But even upon the plan of rotation, the soil becomes at length exhausted, and the cultivator obliged to have recourse to other means of restoring its fertility.

In this case, an interval of repose is considerably efficacious, as may be seen from the increased fertility of fields that have not been ploughed up for many years, such as those used for pasture; or even from that of the walks and paths in gardens when they are again broken up. Hence also the practice of fallowing, and of trenching or deep ploughing, which must have nearly the same effect.

If any one asks how the fertility of a soil is restored by the means now stated, it will be sufficient for the object of the present section to reply that, in the case of draining, the amelioration is effected by means of its carrying off all such superfluous moisture as may be lodged in the soil, which is well known to be prejudicial to plants not naturally aquatics, as well as by rendering the soil more firm and compact. In the case of burning, the amelioration is effected by means of the decomposition of the vegetable substances contained in the turf, and subjected to the action of the fire, which disperses part also of the superfluous moisture, but leaves a residue of ashes favourable to future vegetation. In the case of the rotation of crops, the fertility is not so much restored as more completely developed and brought into action; because the soil, though exhausted for one species of grain, is yet found to be sufficiently fertile for another, the food necessary to each being different, or required in less abundance. It has also been supposed that plants growing long in the same soil, throw out a particular excretion, which is inimical to plants of the same species, though harmless to those of different families and species.

In the case of the repose of the soil, the restored fertility may be owing to the decay of vegetable substances that are not now carried off in the annual crop, but left to augment the proportion of vegetable mould; or to the accumulation of fertilizing particles conveyed to the soil by rains; or to the continued abstraction of oxygen from the atmosphere. In the case of fallows, it is owing undoubtedly to the action of the atmospheric air upon the soil, whether in rendering it more friable, or in hastening the putrefaction of noxious plants; or, it is owing to the abstraction and accumulation of oxygen. In the case of trenching, it is owing to the increased facility with which the roots can now penetrate in the proper depth; and in the case of deep ploughing, it is owing, as it would appear, to the same cause.

But it often happens that the soil can no longer be ameliorated by any of the foregoing means, and in this case there must be a direct and actual application made to it of such substances as are fitted to restore its fertility. And hence the indispensable necessity of manures, which consist chiefly of animal and vegetable remains that are buried and finally decomposed in the soil, from which they are afterwards absorbed by the root of the plant, in a state of solution.

But as carbon is the principal ingredient furnished by manures as contributing to the nourishment of the plant, and is not itself soluble in water, nor even disengaged by fermentation in a state of purity; under what state of chemical combination is its solution effected? Is it effected in the state of charcoal? It has been thought, indeed, that carbon in the state of charcoal, is soluble in water; because water from a dunghill, when evaporated, constantly leaves a residuum of charcoal, as was first ascertained by the experiments of Hassenfratz. But there seem to be reasons for doubting the legitimacy of the conclusion that has been drawn from it; for Senebier found that plants whose roots were immersed in water, took up less of the fluid in proportion as it was mixed with water from a dunghill. Perhaps then the charcoal of water from a dunghill is held merely in suspension, and enters the plant under some other modification.

But if carbon is not soluble in water in the state of charcoal, in what other state is it soluble. It is soluble in the state of carbonic acid gas. But is this the state in which it actually enters the root? On this subject physiologists have been somewhat divided in opinion. Senebier endeavours to prove that carbonic acid gas, dissolved in water, supplies the roots of plants with almost all their carbon, and founds his arguments upon the following facts:—In the first place it is known that carbonic acid gas is soluble in water; in the second place it is known to be contained in the soil, and generated by the fermentation of the materials composing manures; and in the next place it is known to be beneficial to vegetation when applied artificially to the roots, at least in a certain degree. This is evident from the following experiment of Ruckert, as well as from several experiments of Saussure's, previously related. Ruckert planted two beans in pots of equal dimensions, filled with garden mould; the one was moistened with distilled water, and the other with water impregnated with carbonic acid gas. But the latter

appeared above ground nine days sooner than the former, and produced twenty-five beans; while the former produced only fifteen. Now the result of this experiment, as well as the preceding facts, is evidently favourable to the presumption of Senebier, and shows that, if carbonic acid is not the state in which carbon enters the plant, it is at least a state preparatory to it; and there are other circumstances tending to corroborate the opinion resulting from the analysis of the ascending sap of plants. The tears of the vine, when analysed by Senebier, yielded a portion of carbonic acid and earth; and as the ascending sap could not be supposed to have yet undergone much alteration, the carbonic acid, like the earth, was probably taken up from the soil.

But this opinion, which seems to be so firmly established upon the basis of experiment, Hassenfratz strenuously controverts. According to experiments which he had instituted with an express view to the investigation of this subject, plants which were raised in water impregnated with carbonic acid, differed in no respect from such as grew in pure water, and contained no carbon that did not previously exist in the seed. Now if this were the fact, it would be decisive of the point in question. But it is plain from the experiments of Saussure, as related in a preceding section, that Hassenfratz must have been mistaken, both with regard to the utility of carbonic acid gas as furnishing a vegetable aliment, and with regard to the augmentation of carbon in the plant. The opinion of Senebier, therefore, may still be correct.

It must be acknowledged, however, that the subject is not yet altogether satisfactorily cleared up; and that carbon may certainly enter the plant in some state different from that either of charcoal in solution, or of carbonic acid gas. Is not the carbonic acid of the soil decomposed before entering the plant? This is a conjecture of Dr Thomson's, founded upon the following facts: The green oxide of iron is capable of decomposing carbonic acid; and many soils contain that oxide. Most soils indeed, contain iron, either in the state of the brown or green oxide, and it has been found that oils convert the brown oxide into green. But dung and rich soils contain a quantity of oily substance. One effect of manures, therefore, may be that of reducing the brown oxide of iron to the green, thus rendering it capable of decomposing carbonic acid gas, so as to prepare it for some new combination, in which it may serve as an aliment for plants. All this, however, is but a conjecture; and it is more probable that the carbonic acid of the soil enters the root in combination with some other substance, and is afterwards decomposed within the plant itself.

CHAP. XIX.

OF VEGETABLE VITALITY.

Vegetables, as we have already remarked, differ entirely from mineral bodies, in possessing an organized structure; and in obeying laws totally different from those which regulate inorganic matter. In this respect, they nearly resemble animal bodies; and hence, both are said to be endowed with life or vitality. So little is known, however, of the nature of this vitality, either in animals or vegetables, that it need not be surprising if a variety of conflicting theories have been formed by physiologists, to account for its primary cause. While some affirm that the vital actions are the result simply of an organized structure, acted upon by external stimuli; others are disposed to believe in a distinct principle of vitality, which, acting by peculiar laws, moulds and regulates inorganic matter, so as to exhibit all the phenomena of life.

One of the chief arguments in support of a principle of vitality, is the fact that organized bodies are thereby rendered capable of resisting, and counteracting the ordinary laws of chemical affinity. This circumstance, which seems to have been first established by Humboldt, is obviously applicable to the case of animals; as is proved by their processes of digestion and assimulation, whereby the food is converted into chyle and blood, as well as from the various secretions of their several organs, effecting the growth and development of the individual, in direct opposition to the laws of chemical affinity, which, as soon as this principle of vitality ceases to operate, immediately begin to give indications of their action in the incipient symptoms of the putrefaction of the dead body, and its ultimate resolution into the elements of which it was formed. This rule is also applicable to vegetables, as is illustrated in a similar manner by the ascent of the sap, and its ultimate elaboration into the various substances proper to the plant, by a series of operations contrary both to the laws of gravity and chemical action. At the death of the plant, too, and on the cessation of its principle of vitality, the usual chemical agencies are resumed, and a similar decomposition takes place, as in the case of animals. The vegetable economy, therefore, exhibits phenomena totally different from that which characterises mineral and inorganic bodies. Vegetable life, therefore, is upheld by different and peculiar laws; and it may be, is in its essence a peculiar principle, distinct from the matters which it moulds and forms into various shapes and textures. Vegetable life, then, is characterised by the following properties.

Excitability. A remarkable property of or-

ganised vegetable structure, is its susceptibility of being acted on by external stimuli, whereby all the phenomena of vegetable life are called into existence. These stimuli are light, heat, and electricity; and we shall consider their influence separately.

Light. The action of light is very perceptible in plants, as affecting their leaves, stems, flowers, and even roots. It is to this influence of light that the bending of the stem and leaves of plants is attributable, producing in them, as it were, a direct motion towards the luminous quarter. Bonnet planted three beans for the purpose of comparative experiment; one in the open air, another in a tube of glass covered at the top; and a third in a tube of wood covered at the top also. The first plant was strong and luxuriant, the second was also strong, and inclined towards the sun; but the third, though it grew tall, was pale and sickly. Hence it is, upon the principle of the exclusion of light, that plants are blanched, as in the case of the blanching of celery. The direction and luxuriance of the branches depend also upon the influence of light, as may be remarked in all plants growing in hot-houses, the branches of which are not so conspicuously directed either to the heated place in quest of heat, or to the door or open sash, in quest of air, as to the sun by a mysterious attraction for his light. It may be observed also, that the branches of vegetables turned towards the south, are always more luxuriant than those on the north, or at least, on that side which is most fully exposed to the influence of light.

The position of the leaf is also strongly affected by the action of light, to which it uniformly turns its upper surface. This may be observed in trees trained to a wall, from which the upper surface of the leaf is necessarily always averted, being on a south wall turned to the south; and on a north wall turned to the north. And if the upper surface of the leaf is forcibly turned towards the wall, and confined in that position for a length of time, it will soon assume its original position upon regaining its liberty, but particularly if the atmosphere is clear. Bonnet tried to retain a leaf in its inverted position, by means of twisting the leaf stalk; but it was always found to untwist itself again in the course of a short time, and again to present its upper surface to the sun or light. This it was sometimes found to do, even in the night; but always the most expeditiously in young subjects. If the experiment is often repeated, the leaf resumes its original position with more difficulty, and exhibits evident marks of being injured by the exertion, in the appearance of several black spots about the veins of the under surface, and in the scaling off of the cuticle. All leaves, however, are not equally susceptible to the action of the stimulus of light. Thus the leaves of the common mallow show few signs of this susceptibility; and it is the same with all those leaves of a narrow shape. The leaves of the misletoe have never been known to resume a former position in consequence of any change in the position of the branch, because, as Smith observes, they are perhaps equally susceptible on both sides. Succulent leaves, notwithstanding their thick and firm texture, are said to be particularly susceptible; and if the leaf of the vine is even separated from a branch, and suspended by a fine thread, so as that the upper surface shall be turned from the light, it will yet gradually alter its position till it comes round again to it. This experiment requires to be made with great care and delicacy, lest the leaf should be made to turn by means of the effect of the atmosphere upon the thread.

In speculating on these effects, it may be asked if light is here the sole agent; or, whether something may not also be due to the influence of heat and moisture. To set this question at rest, Bonnet placed several plants in a heated stove, and he found that the stems were not turned to the side from whence the greatest heat proceeded, but to a small opening in the stove, admitting the light. He also found that the leaves of the vine turned towards the light exactly in the same manner when placed in water, as when left in the open air; whence it may be naturally inferred, that to the influence of light alone is due the motions of plants already described.

But as light produces such effects upon the leaves, so darkness, or the absence of light, produces an effect quite the contrary; for it is well known that the leaves of many plants assume a very different position during the night from what they have in the day. This is particularly the case with winged leaves, which, though fully expanded during the day, begin to droop and bend down about sun-set, and during the fall of the evening dew, till they meet together on the inferior side of the leaf-stalk, the terminal lobe, if the leaf is furnished with one, folding itself back till it reaches the first pair; or the two side lobes, if the leaf is trifoliate, as in the case of common clover, which fact seems to have been first observed by the daughter of Linnæus. So also the leaflets of the false acacia and liquorice hang down during the night, on each side of the midrib, but do not meet beneath it. The leaves of the sensitive plant (*mimosa pudica*) fold themselves up along the common foot-stalk, so as to overlap one another. But, perhaps, this effect is produced partly by the agency of moisture, as it is accelerated by dews and rains, and may even be occasioned by artificial watering. On referring to our account of the theories of Dutrochet of endosmose and exosmose, already given, some farther light on this subject may be obtained.

During the absence of light, too, it is highly

probable that plants undergo a change in their functions; or that, during this period, they perform a process analogous to breathing, giving out their excess of carbonic acid, and taking in a quantity of oxygen; whereas, during the day, their digestive process consists in decomposing carbonic acid and water, and liberating a quantity of superfluous oxygen.

The action of light is the chief agent in the expansion of the blossoms of flowers. Many plants do not fully expand their petals except when the sun shines; and hence they alternately open them during the day, and shut them up during the night. This is distinctly observable in the case of the garden pea, and other papilionaceous flowers, which spread out their wings in fine weather to admit the rays of the sun, and again fold them up as the night approaches. It may be exemplified also in all compound flowers, as in the dandelion and hawkweed. But the most remarkable case of the kind is that of the celebrated *lotus*, or lily of the Nile, as described by Theophrastus and Pliny. This plant is represented as raising and expanding its blossom during the day, and closing and sinking down beneath the surface of the water at night, so as to be beyond the grasp of the hand, and thus remaining till morning again calls it up to the air and light.

But though the opening and shutting of the blossoms of plants takes place on the change from day to night; yet all plants do not open and shut them at the same time exactly. Plants of the same species are, however, wonderfully regular, even to an hour, other circumstances being the same; and hence has been constructed what botanists call "Flora's Time piece." Flowers requiring a slight stimulus of light, open early in the morning, others requiring more and more open in succession until noon. Many do not fully expand till mid-day, or a little later; and some, whose extreme delicacy cannot bear the action of full light at all, open only at night; of this nature is the *cactus grandiflora*, or night blowing *cereus*.

Some, however, have doubted whether light be the sole agent in this expansion of the blossoms, as it has been observed that equatorial flowers open always at the same hour; and that tropical flowers change their hour of opening according to the length of the day. It has been observed also, that the flowers of plants that have been removed from a warmer to a colder climate, expand at a later hour in the latter. A flower that opens at six in the morning at Senegal, will not open in France or England till eight or nine, nor in Sweden till ten. A flower that opens at ten at Senegal, will not open in France or England till noon, or later, and in Sweden it will not expand at all. Neither will a flower open at all in England or France, which delays its expansion in Senegal till noon or later. This seems as if a certain amount of heat were as necessary as light, though the opening of such as blow only at night cannot be attributed to either of these stimulants. It is highly probable that the expansion of some flowers depends as much on other conditions of the air, as on the presence or absence of light and heat, such as its moisture or dryness, and its electric condition. Hence it is, that their opening or shutting betokens meteorological changes. Thus, if the Siberian sow-thistle shuts at night, the ensuing day will be fine; and if it opens, it will be cloudy and rainy. If the African marygold continues shut after seven o'clock in the morning, rain may be soon expected; and if the *convolvulus arvensis*, *calendula fluvialis*, or *anagallis arvensis*, are even already open, they will shut upon the approach of rain, the last of which, from its nice susceptibility in this respect, has been called "the poor man's weather glass."

Some flowers not only indicate the same influence by expanding under his presence, but they also follow him in his course, by bending or turning gradually from the east to the west as the day advances; and thus, looking towards the east in the morning, towards the south at noon, and to the west in the evening, while during the night they again return to their eastern position, to meet the rising luminary. Such flowers have been called *heliotropes*, on account of their thus following the course of the sun; and the movement they thus make has been called by the astronomical term of their *nutation*. The ancients had remarked this circumstance long before they had made any considerable progress in botany; and it had even been interwoven into their mythology, having, according to their legends, originated in one of the metamorphosis of early ages. Clytia, inconsolable for the loss of the affections of Sol, by whom she had been formerly beloved, and of whom she was still enamoured, is represented as brooding over her griefs in silence and solitude; where refusing all sustenance, and seated upon the cold ground, with her eyes invariably fixed on the sun during the day, and watching for his return during the night, she is at length transformed into a flower, retaining as much as a flower can retain it, the same unaltered attachment to the sun. This is the flower which is denominated the heliotrope by the ancients, and described by Ovid as "the flower which turns to the sun." But it must be remarked that the flower thus alluded to by Ovid, cannot be the heliotrope of the moderns, because Ovid describes it as resembling the violet; much less can it be the modern sun-flower, which is a native of America, and could not consequently have been known to the Latin poet; so that the true *heliotropium* of the ancients yet remains unascertained. Bonnet has remarked

that the ripe ears of corn which bend down with the weight of grain, scarcely ever incline to the north, but always more or less in a southerly direction; of the accuracy of which remark, any one may easily satisfy himself by looking at a field of wheat ready for the sickle; he will find the whole mass of ears nodding, as if with one consent, to the south. The immediate cause of the phenomena, has been supposed to be a contraction of the fibres of the stem or flower stalk, on the side exposed to the sun; and the contraction has been thought by De la Hire, and Dr Hales, to be occasioned by an excess of transpiration on the sunny side, which is probably near the truth.

Heat. A certain medium degree of heat is essential to the first development of the vegetable germ, and to the future life of the plant.

No plants will vegetate at a temperature so low as 32°, or freezing point of Fahrenheit; and few will bear a higher temperature than 150 or 160, although instances have been adduced of plants vegetating in situations where the temperature, in consequence of volcanic action and boiling springs, was not less than 212. The points we have indicated, however, may be looked upon as the extremes of vegetable existence. It is true plants, like animals, can bear a much greater degree of cold than that of 32°; but any temperature, much under this, suspends their vegetative powers for the time, which are only resumed after an elevation of temperature where the juices of the soil on which they live are in such a fluid state as to be capable of being absorbed by their roots.

The influence of heat, too, has a marked effect on the development of the different parts of plants; and thus leaves, blossoms, and fruit make their appearance in successive periods or seasons. From this circumstance, Linnæus constructed his Calendar of Flora, which comprehends a view of the successive periods at which plants blossom and produce fruit. With regard to the frondescence, it must be evident to all that plants do not produce their leaves at the same time. Thus, the honey-suckle protrudes them in the month of January; the gooseberry, currant, and elder, in the end of February, or beginning of March; the willow, elm, and lime tree, in April; and the oak and ash, which are always the latest among trees, in the beginning or towards the middle of May. Many annuals do not come up till after the summer solstice; and many mosses not till after the commencement of winter. This gradual and successive unfolding of the leaves of different plants, seems to arise from the peculiar susceptibility of the species to the action of heat, as it requires a greater or less degree of it to give the proper stimulus to the vital energies of the plants. But a great many circumstances will always concur to render the time of the unfolding of the leaves somewhat irregular, because the mildness of the season is by no means uniform at the same period of advancement; and because the leafing of the plant depends upon the peculiar degree of temperature, and not upon the return of a particular day of the year. Hence it has been thought that no rule could be so good for directing the husbandman in the sowing of his several sorts of grain, as the leafing of such species of trees as might be found by observation, to correspond best to each sort of grain respectively in the degree of temperature required.

Linnæus, who instituted some observations on the subject, about the year 1750, with a view chiefly to ascertain the time proper for the sowing of barley in Sweden, regarded the leafing of the beech tree as being the best indication for that grain, and recommended the institution of similar observations with regard to other sorts of grain, upon the ground of its great importance to the husbandman. But however plausible the rule thus suggested, may be in appearance, and however pleasing it may be in contemplation, it is not likely that it will ever be much attended to by the husbandman, because nature has furnished him with indications that are still more obvious in the very evidence of his own feelings, as well as perhaps more correct; as all trees of the same species do not come into leaf precisely at the same time, and as the weather may change even after the most propitious indications.

The flowering of the plant, like the leafing, seems to depend upon the degree of temperature induced by the returning spring, as the flowers are also protruded pretty regularly at the same successive periods of the season. The mezereon and snow drop blossom in February, the primrose in the month of March, the cowslip in April, the great majority of plants in the months of May and June; many in July, August, and September; some not till the month of October, as the meadow saffron; and a few not even till winter, as the arbutus and laurestinus. Such at least is the period of their flowering in this country; but in warmer climates they are earlier, and in colder regions later.

In tropical countries, where the temperature is steadily at a high elevation, it often happens that plants will blossom more than once in the year, because they do no more require to wait till the temperature is raised to a certain height, but merely till the development of their parts can be effected on the regular operations of nature under a temperature already sufficient. For the greater part, however, they flower during our summer, though plants in opposite hemispheres, flower in opposite seasons. In all climates, however, the time of flowering depends also much on the elevation of the place above the level of the sea, as well as on other causes affect-

ing the degree of heat. Hence plants occupying the polar regions, and plants growing on the summits of high mountains of southern latitudes, are in flower at the same season. And hence the same species of flowers are later of blossoming in North America, than in the same latitudes in Europe, because the surface of the earth is higher, or the winters more severe.

There is also much diversity in the degree of warmth, and its duration necessary for the maturation of the fruits of vegetables, as well as for their frondescence and flowering. But the plant that flowers the soonest, does not always ripen its fruit the soonest. The hazel tree, which blows in February, does not ripen its fruit till autumn, while the cherry, which does not blow till May, ripens its fruit in June. It may be regarded, however, as the general rule, that if a plant blows in spring, it ripens its fruit in summer, as in the case of the currant and gooseberry; if it blows in summer, it ripens its fruit in autumn, as in the case of the vine; and if it blows in autumn it ripens its fruit in winter. But the meadow saffron, which blows in the autumn, does not ripen its fruit till the succeeding spring. Such are a few of the facts on which a Calendar of Flora might be formed. They have not hitherto been very minutely attended to by botanists, and perhaps by many may be reckoned more curious than practically useful. At all events, all such records afford pleasing associations connected with the ever varying phases of the year, and the phenomena are at least sufficiently striking as to have attracted the attention even of savages. Thus, some tribes of American savages act upon the very principle suggested by Linnæus, and plant their corn when the wild plum blooms, or when the leaves of the oak are about as large as a squirrel's ears. The names of some of their months are also derived from the stages of vegetation. One is called the budding month, and another the flowering month; one the strawberry month, and another the mulberry month; and the autumn is designated by a term signifying the fall of the leaf.

There are also several other ways in which the agency of heat may be observed, as exciting the vital energies of plants. Thus, the leaflets of some of the leguminous plants, when exposed to the action of an ardent sun, are often erected into a vertical position on each side of the leaf-stalk, which they sometimes even pass, so as to close together. Under similar circumstances the leaves of the Indian mallow become concave, and it seems as if the effect were produced merely, or at least chiefly, by means of heat, because the same effect may be produced even by means of the application of a hot iron; and yet the leaflets of many such plants fold themselves back at night, so as to meet under the leaf-stalk. Several species of mimosa also, exhibit a singular phenomenon even in the common foot-stalk, which is found to have a sort of natural movement dependent upon the temperature, so that it is elevated in the course of the day, and depressed at night. According to the observations of Du Hamel, at nine o'clock in the morning of a September day, the weather being moderately fine, the foot-stalk of a leaf of *mimosa pudica*, formed by its position an angle of 100°; with the lower part of the stem at noon, it formed an angle of 212°; at three in the afternoon it had fallen to an angle of 100°; and during the night it fell to an angle of 90°, thus indicating an evident susceptibility to the stimulus of heat.

As a summer heat is necessary to the full and perfect exertion of the functions of vegetables; so the depression of temperature consequent upon the cold of winter, has been thought to suspend the exertion of those functions altogether. But this opinion requires some limitation; for some plants expand their leaves and flowers even in winter, such as many of the mosses; and others develope their buds during this season, in which there is a regular and gradual progress of vegetation till they expand in spring. The sap, it is true, flows much less freely, but is not entirely stopped. Hales lopped off some branches from the hazel, and vine, and jessamine, respectively, in course of the winter, and covered the section of the separated branches with mastic; and in a few days these branches were found to have lost considerably in weight; whence he inferred the motion of the sap, because it seems reasonable to suppose, that this dissipation of sap would have been repaired, if the branches had remained on their parent trees. Du Hamel planted some young trees in the autumn, cutting off all the smaller fibres of the root, with a view to watch the progress of the formation of new ones. At the end of every fortnight he had the plants taken up and examined with all possible care, to prevent injuring them; and found, that when it did not actually freeze, new roots were uniformly developed. Hence it follows, that even during the period of winter, when vegetation, to all appearance, seems totally at a stand, the tree being stripped of its foliage, and the herb apparently withering in the frozen blast, still the energies of vegetable life are exerted, and still the vital functions are at work, carrying on, in the interior of the plant, concealed from human view, and sheltered from the piercing frosts, operations necessary to the preservation of vegetable life, or development of future parts; though it requires the returning warmth of spring to give that degree of velocity to the juices which shall render their motion evident to man, as well as that expression of the whole plant, which is the most evident token of

life; just in the same way as the processes of digestion, assimulation, and circulation are carried on in the sleeping animal.

Heat, then, is a most important stimulus in the operations of the vegetable functions, accelerating the motion of the sap, and exciting all the other actions; for the sap flows much more copiously as the warmth of the season increases; or as the artificial temperature of the hot-house is raised. At the same time, it is ascertained that excessive heat impedes the progress of vegetation as well as extreme cold, both being equally prejudicial. Hence the sap flows more copiously in the spring and autumn, than in either the summer or winter months. This may readily be proved by watching the progress of the growth of the annual shoot, which, after having sprung up rapidly in spring, remains for a while stationary during the great heat of summer, but is again elongated during the more moderate temperature of autumn.

Other stimulants have been found to accelerate the growth of vegetables when dissolved in water, and applied to the roots or branches. Thus the germination of peas is accelerated by moistening them in water impregnated with oxymuriatic acid gas, a fact first ascertained by Humboldt; and the vegetation of the bulbs of the hyacinth and narcissus is accelerated by the application of nitre in solution. Dr Barton of Philadelphia found that a decaying branch of *liriodendron tulipiferum*, and a faded flower of the yellow iris, recovered, and continued long fresh, when put into water impregnated with camphor, though a flower and branches, in all respects similar, did not recover when put into common water.

Plants have also the power of generating heat, and in this respect show a wonderful coincidence with the more perfect vital powers of animals. The heat of plants is evinced by the more speedy melting of snow when in contact with their leaves or stems, compared with what is lodged upon inorganic bodies, provided the preceding frost has been sufficiently permanent to cool those substances thoroughly. Mr Hunter detected this heat by the rise of the thermometer, applied in frosty weather, to the internal parts of vegetables newly opened. And Lamarck mentions an extraordinary degree of heat evolved by the *arum maculatum*, or wake robin, about the period when the sheath is about to open. Most plants, at the period of inflorescence, exhibit this internal heat in a greater degree than at other times.

Electricity. There can be no doubt but that electricity is one of the stimuli of vegetable life, although its mode of action is not yet ascertained. Vegetation is seen to increase prodigiously during electric changes of the atmosphere, and especially in that condition of it when the air is positively charged with the electric fluid. It is probable, too, as we have explained when treating of the theory of the ascent of the sap, that electricity is concerned in this phenomenon, and perhaps in the elaboration and secretion of the various vegetable juices and products. The influence of light on vegetables has already been explained; and when we call to mind the recent discoveries by which it is shown that, in the sun's rays, there are some which exercise a powerful chemical action on bodies, it may not be without probability conjectured, that these chemical rays have a considerable influence in imparting colour, and promoting the various chemical changes which take place in vegetable bodies.

Irritability. This property of plants corresponds somewhat to the muscular irritability of animals. Plants are not only susceptible to the action of light and heat, but also to the contact of external matter. It is true that this susceptibility is not very apparent in the generality of plants; but in a few, especially the *mimosa*, or sensitive plant, a decided shrinking and folding up of the leaves takes place when they are touched by the finger, or any other body. The twisting of tendrils round any other body; the bending of stems and branches; and, above all, the extension of roots, as influenced by moisture or particular soils, are all, however, evident proof of this irritability.

Du Hamel made the following experiments, with a view to ascertain the susceptibility of the sensitive plant. At eight o'clock in the morning of a day in September, a leaf-stalk of a sensitive plant, formed with the lower part of the stem an angle of 135°, which, upon being touched, fell to an angle of 80°: an hour afterwards it rose again to 135°; and upon being touched a second time, it fell again also to 80°. An hour and a half afterwards it rose to 145°, and upon being touched fell to 135°, where it remained till five o'clock in the evening, when upon being touched it fell to 110°. Hence it follows, that the susceptibility is greatest in the morning, or during the heat of the day; but the leaf recovers itself sooner or later, according to the vigour of the plant, the season of the year, and temperature of the atmosphere, as well as the hour of the day at which the experiment is made, though it does not always recover itself in the same way; for sometimes the common foot-stalk recovers first, sometimes the lateral foot-stalk, and sometimes the leaflets themselves.

The leaves of *dionœa muscipula*, or Venus fly-trap, are also extremely susceptible to the action of accidental stimuli. They are all radical, and approaching to battledore-shaped, with a sort of circular process at the apex, which is bisected by a tendril, and ciliated with fine hairs like an eyelash. This circular process is

the seat of irritability, and if it is touched with any sharp pointed instrument, or if an insect alights upon it, the segments *b b*, immediately collapse, and adhere so closely that the insect is generally squeezed to death in its grasp, or at the least, detained a prisoner. A similar susceptibility to the action of accidental stimuli, has been observed in the leaves of the several British species of *drosera* or sun dew. But sometimes the irritability resides in the flower, and has its seat either in the stamens or style. The former case we have already alluded to in the blossoms of the common barberry, the stamens of which, when undisturbed, lie reclined upon the petals which shelter the anthers under their concave tips. But no sooner is the inner side of the filament touched either accidentally or intentionally, with any sharp pointed substance, than the stamen immediately bends itself inwards, till its anther strikes against the stigma. This fact had been long familiar to botanists; but it remained to be ascertained whether the susceptibility in question was confined to the inner side of the filament merely, or whether it pervaded the whole stamen. With this object in view, Sir J. E. Smith having procured some flowers fully blown, on the 25th of May, examined them with great care; and after applying the point of a quill or fine bristle, with all possible delicacy, to every part of the surface of the stamen, he found that it no where exhibited any indications of susceptibility, except on the inner side of the filament, and towards the base. It had been thought that the stamens possessed this property only at the time of shedding the pollen; but Sir J. E. Smith found that they possess it at all ages, and even when the petal with its annexed filament has fallen to the ground, they gradually recover their original situation, and are capable of being again stimulated as before. The stamens of *cactus tuna*, a sort of Indian fig, are said to be endowed with a similar irritability. If a quill or feather is drawn across its long and slender filaments which surround the germen in great numbers, they will immediately begin to bend to the one side, and will in a short time sink down to the base of the flower. The case in which the seat of irritability is confined to the style is exemplified in *stylidium glandulosum*, a native of New Holland. The style of this flower, which is about an inch in length, is bent backward a little above the base, in the manner of the piece of iron that is fixed to the end of a shepherd's crook, or to the end of the pole of a chaise, so that the style forms a sort of hook with the flower-stalk, the stigma being reflected so as in many cases to touch it. But if the stigma is itself touched with the point of the finger or other suitable instrument, the style is immediately put into motion, and flies back till it bends itself as much in a contrary direction, and on the other side of the flower as it did in its first direction.

70.

CHAP. XX.

DISEASES OF VEGETABLES.

Vegetables being organized structures, are liable to disease as well as animals. The minuteness and delicacy of their internal cells and tubes render them frequently liable to disorganization; and their soft and succulent exteriors are continually exposed to abrasions and injuries from the contact of other bodies. Besides these, the influence of the atmosphere, as regards its moisture and dryness, or electric condition, materially affects the health and vigour of plants. Vegetables, like animals, are also liable to the attacks of parasites; and thus fungi or minute plants, and insects and animalcules, have a very prejudicial effect upon many plants. The diseases of vegetables have been classed under the following heads: blight, smut, mildew, honeydew, dropsy, flux of juices, gangrene, etiolation, suffocation, contortion, consumption.

Blight. This is one of the most common diseases which affect vegetables, and yet one on the nature of which the greatest differences of opinion have prevailed. The disease seems to have been observed by, and to have been familiar to the ancient Greeks. They regarded it as a scourge from heaven, or from their enraged deities; and therefore did not trouble themselves in the investigation of its nature or cause. It was familiar to the Romans also, under the name of *rubigo*, or rust; and this people regarded it in the same light as the Greeks, believing it, however, to be under the special influence of a particular deity named *Rubigus*, whom they solemnly invoked in order to keep this calamity from their trees and corn fields. In modern times it is not less well known; yet still its true nature remains matter of speculation. The fact is, that there may perhaps be several varieties, and the disease all arising from different causes.

Dr Keith has endeavoured to point out at least three species. 1st, Blight arising from cold and frosty winds: 2d, from a peculiar vapour, perhaps originating in certain electric conditions of the atmosphere: and, 3d, from the presence of a minute parasitical fungus.

The first kind of blight is often occasioned by the cold and easterly winds of spring, which nip

and destroy the tender shoots of the plant, by stopping the current of the juices. The leaves which are thus deprived of their due nourishment, wither and fall; and the juices that are now stopped in the passage, swell and burst the vessels, and become the food of innumerable little insects, that soon after make their appearance. Hence they are often mistaken for the cause of the disease, instead of the consequences of it; the farmer supposing they are wafted to him on the east wind, while they are only fostered in the superabundant and obstructed juices, which form an appropriate nursery for their eggs and young. These propagating, will undoubtedly contribute to the extension of the disorder, as they increase in proportion to the supply of suitable food.

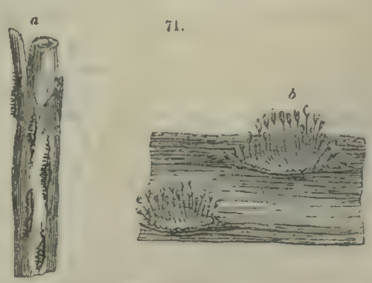
A similar disease is also occasioned by the early frosts of spring. If the weather is prematurely mild, the blossom is forced before its time, a circumstance which, though hailed by the inexperienced with pleasure, is yet viewed by the judicious with fear. For it frequently happens that this premature blossom is totally destroyed by subsequent frosts, as well as both the leaves and shoots; which consequently wither and fall, and injure, if they do not actually kill the plant. This evil is also often augmented by the unskilful gardener, even in attempting to prevent it, that is, by matting up his trees too closely, or by keeping them covered in the course of the day, and thus rendering the shoots so tender, that they can scarcely fail to be destroyed by the next frost.

The second kind of blight generally happens in summer, when the grain has attained to its full growth, and when there are no cold winds or frosts to occasion it. Such was the blight that used to damage the vineyards of ancient Italy, and which is yet found to produce great destruction in the hop plantations and wheat fields of Britain.

The Romans had observed that it generally happened after short but heavy showers, occurring about noon, and followed by clear sunshine about the season of the ripening of the grapes; and that the middle of the vineyard suffered the most. This corresponds pretty nearly to what is in England called the fire-blast among hops, which has been observed to take place most commonly about the end of July, when there has been rain, with a hot gleam of sunshine immediately after. The middle of the hop ground is also the most affected, whether the blight is general or partial; and is almost always the point in which it originates. In a particular case, minutely observed by Hale, the damage happened a little before noon, and the blight ran in a line, forming a right angle with the sunbeams at that time of the day. There was but little wind, which was, however, in the line of the blight. Wheat is also affected with a similar sort of blight, and about the same season of the year, which totally destroys the crop. "In the summer of 1809," says Dr Keith, "I had watched the progress of the growth of a field of wheat on rather a light and sandy soil, merely from having had occasion to pass through it every Sunday, in going to serve at church. It came up with every appearance of health, and also into ear, with a fair prospect of ripening well. I had taken particular notice of it on a Sunday about the beginning of July, as exceeding any thing I should have expected on such a soil; but on the following Sunday, I was surprised to find a portion of the crop on the east side of the field, to the extent of several acres, totally destroyed, being shrunk and shrivelled up to less than one-half the size of what it had formerly been; with an appearance so withered and blasted, that I for some time imagined I had got into the wrong field; the rest of the field produced a fair crop."

The third kind of blight seizes on the leaves and stem, both of herbaceous and woody plants, such as *euphorbia cyparissus*, *berberis vulgaris*, and *rhamnus catharticus;* but more generally grasses, and particularly our most useful grains, wheat, barley, and oats. It generally assumes the appearance of a rusty-looking powder, that soils the finger when touched. "On the 25th of March, 1807," says Dr Keith, "I examined some blades of wheat that were attacked with this species of blight; the appearance was that of a number of rusty-looking spots or patches, dispersed over the surface of the leaf, exactly like that of the seeds of dorsiferous ferns, bursting their indusium. Upon more minute inspection, these patches were found to consist of thousands of small globules, collected into groups beneath the epidermis, which they raised up in a sort of blister, and at last burst. Some of the globules seemed as if imbedded even in the longitudinal vessels of the blade. They were of a yellowish or rusty brown, and somewhat transparent. But these groups of globules have been ascertained, by Sir J. Banks, to be patches of a minute fungus, the seeds of which, as they float in the air, enter the pores of the epidermis, of the leaf particularly, if the plant is sickly; or they exist

71.



a, Stem of mildewed wheat; *b*, The fungus magnified.

in the manure or the soil, and enter by the pores of the root. This fungus is known among farmers by the name of the red rust, and as it affects the stalk and leaves only, it does not materially injure the crop. There is another species of fungus known to the farmer by the name of *red gum*, which attacks the ear only, and is extremely prejudicial. In the aggregate it consists of groups of minute globules, interspersed with transparent fibres; the globules are filled with a fine powder, which explodes when they are put into water. It is very generally accompanied with a maggot of a yellow colour, which produces a fly, well known as the destructive wheat-fly.

Smut is a disease extremely frequent in cultivated corn. It consists of a conversion of the farina of the grain, together with the integuments, and even part of the husk or pericarp, into a black soot-like powder. If the injured ear is struck with the finger, the powder will be dispersed like a cloud of black smoke; and if a portion of the powder is wetted by a drop of water, and put under the microscope, it will be found to consist of millions of minute and transparent globules, which seem to be composed of a clear and glairy fluid, encompassed by a thin membrane. This disease does not affect the whole body of the crop; but the smutted ears are sometimes very numerously dispersed through it. Some have attributed it to the soil in which the grain is sown, to the manure, or to contamination of the seed. This latter is the most likely cause, as Willdenow regards it as originating in a small fungus plant, which multiplies and extends till it occupies the whole ear. As a proof that the minute seeds of this fungus may attach themselves to the grain, it is found that washing the seed with a solution of arsenic, or sulphate of copper, of such strength as to destroy the vegetating power of the parasitic plant, but not the germ of the grain itself, will effectually prevent the recurrence of smut. A modification of this disease usually seizes on ears of wheat, and is called by the farmer smut-ball. In this case, the cotyledons only are converted into a black mass, while the enveloping membranes remain sound. The ear is not much altered in its external appearance, and the diseased grain contained in it will even bear the operation of thrashing; and thus the fungi mingle with the bulk, and of course tend to propagate the same disease, if the grain be used for seed.

Mildew consists in a thin whitish coating with which the leaves of vegetables are sometimes covered, causing their decay and death, and of consequence an interruption of the functions of the plant. It is frequently found on the leaves of *tussilago farfara*, *humulus lupulus*, *corylus avellana*, and the white and yellow dead nettle. It is also found to attack wheat fields, in the form of a glutinous exudation. According to Willdenow, it is occasioned either by the growth of an exceedingly minute fungus, the *mucor eresyphe* of Linnæus, or by a sort of whitish slime, which a species of aphis, or plant louse, deposits upon the leaves. Soot is said to prevent its occurrence.

Honey dew is a sweet and clammy substance which coagulates on the surface of the leaves during hot weather, particularly on the leaves of the oak tree and beech; and is regarded by some as the excrement of the plant louse, while others look on it as an exudation of the juices of the plant. The leaves of the beech tree on the occurrence of an unfavourable wind, become covered with a glutinous coating, similar in flavour to the fluid obtained from the trunk, and in every respect resembling the honey dew of other plants. Saccharine exudations are frequently found on the leaves of many plants, though not always distinguished by the name of honey dew, which term should be applied only when the exudation is in such excess as to cause disease. For if it is to be applied to all saccharine exudations whatever, these must be included under the term honey dew: the saccharine exudation observed on the orange tree, by De la Hire, together with that on the lime tree, which is more glutinous; and of the poplar, which is more resinous, as also that of the *cistus creticus*, from which the gum resin labdanum is collected by means of beating the shrub with leathern thongs, and of the manna which exudes from the ash tree of Italy, and the larch of France. It is also possible that the exudation of excrement constituting honey dew, may occasionally occur without producing disease; for if it should happen to be washed off soon after by rains or heavy dews, then the leaves will not suffer.

Dropsy. When the atmosphere is surcharged with moisture, or too much water is applied to the roots of plants, an excess of their juices occurs, which has some resemblance to the dropsy of animals. That is, their absorbing actions become too great for their exhaling. Willdenow describes it as occasioning a preternatural swelling of particular parts, and inducing putrefaction. It occurs chiefly in bulbous and tuberous rooted plants, which are often found much swelled after rain. It affects fruits also, which it renders watery and insipid. It prevents the ripening of seeds, and occasions an immoderate production of roots from the stem. Succulent plants in particular are apt to suffer from too profuse waterings; and the disease thus occasioned is generally incurable. The leaves drop even though plump and green; and the fruit rots before reaching maturity. In this case, the absorption seems to be too great, in proportion to the transpiration; while a soil too richly manured,

produces similar effects. Du Hamel planted some elms in a soil that was particularly well manured, and accordingly they pushed with great vigour for some time; but at the end of five or six years they all died suddenly. The bark was found to be detached from the wood, and the cavity filled up with a reddish coloured water.

Some trees, but particularly the oak and birch, are liable to a great loss of sap, either bursting out spontaneously, owing to a superabundance of juices, or issuing from accidental wounds. Sometimes it is injurious to the health of the plant; while in other cases it has no such effect. The theory of the ascent of the sap, as proposed by Dutrochet, and already detailed in these pages, may perhaps account for diseases of this nature, by supposing an excess of the action of endosmose over that of exosmose.

There is a spontaneous extravasation of the sap of the vine, known by the name of the tears of the vine, which is not injurious, as it often happens that the root imbibes sap which the leaves are not yet prepared to throw off, because not yet sufficiently expanded, owing to an inclement season; the sap which is first carried up being propelled by that which follows, ultimately forces its way through all obstructions, and exudes from the bud. But this is observed only in cold climates; for in hot climates, where the development of the leaves is not obstructed by cold, they are ready to elaborate the sap as soon as it reaches them. There is also a spontaneous extravasation of proper juice in some trees, which does not seem in general to be injurious to the individual. Thus, the gum which exudes from cherry, plum, peach, and almond trees, is seldom detrimental to their health, except when it insinuates itself into the other vessels of the plant, and occasions obstructions. But when the sap ascends more copiously than it can be carried off, it sometimes occasions a fissure of the solid parts, inducing disease or deformity, by encouraging the extravasation and corruption of the ascending or descending juices. Sometimes the fissure is occasioned by means of frost, forming what is called a double alburnum; that is, first, a layer that has been injured by the frost, and then a layer that passes into wood. Sometimes a layer is partially affected, and that is generally owing to a sudden and partial thaw on the south side of the trunk, which may be followed again by a sudden frost. In this case the alburnum is split into clefts or chinks, by the expansive force of the freezing sap. But a cleft thus occasioned often degenerates into a chilblain, that discharges a blackish and acrid fluid, to the great detriment of the plant, particularly if the sore is so situated that rain and snow will lodge in it, and become putrid. The same injury may be occasioned by the bite or puncture of insects, while the shoot is yet tender, and as no vegetable ulcer heals up of its own accord, the sooner a remedy is applied to it the better, as it will, if left to itself, ultimately corrode and destroy the whole plant, bark, wood, and pith. The only remedy is the excision of the part affected, and the application of a coat of grafting wax.

Gangrene. There are two varieties of this disease. The one arising from an excessive degree of temperature; the other from the extreme of cold. A very low temperature shrivels and destroys the vitality of green leaves and shoots, converting them from the natural green to a black or brown. The inner bark also becomes affected from the same cause, and thus the destruction of the whole plant follows. The effects of excessive heat are nearly similar, as may be witnessed in tropical climates, and in our very hot summers; and even under ordinary heat, when the roots of trees or vegetables are unduly exposed to the sun.

Sometimes gangrene is caused by the too rapid growth of a particular branch, depriving the one that is next it of its due nourishment, and hence inducing its decay. Sometimes it is occasioned by parasitical plants, as in the case of the bulbs of saffron, to which a species of *lycoperdon* often attaches itself, and totally corrupts. The harmattan winds of the coast of Africa kill many plants, by inducing a kind of gangrene that withers and blackens the leaves, and finally destroys the whole plant.

Plants are sometimes affected with a gangrene, by which a part becomes first soft and moist, and then dissolves into foul ichor. This is confined chiefly to the leaves, flowers, and fruit. Sometimes it attacks the roots also, but rarely the stem. It seems to be owing, in many cases, to too wet or too rich a soil; but it may originate in contusion, and may be caught by infection.

Menonville, in his work on the culture of the nopal, as the food of the cochineal insect, gives several interesting notices of this disease. This writer travelled many years ago through the Spanish settlements in South America, chiefly noted for the cultivation of the cochineal insect, on purpose to transport it clandestinely to some of the French islands. Such were the supineness and ignorance of the Spaniards, that he succeeded in conveying not only the living insects, but the bulky plant necessary for their sustenance, notwithstanding severe edicts to the contrary. He had attended previously to the management of the nopal, and made his remarks on the diseases to which it is liable. Of these, the gangrene is extremely frequent in the true nopal of Mexico, beginning by a black spot, which spreads till the whole leaf or branch rots off, or the shrub dies. But the same kind of plant is often affected with a much more serious disease, called by Thiery "la dissolution." This

seems to be a sudden decay of the vital principle, like that produced in animals by lightning. In an hour's time, from some unknown cause a joint, a whole branch, or sometimes an entire plant of the nopal, changes from apparent health to a state of putrefaction or dissolution. One minute its surface is verdant and shining, the next it turns yellow, and all its brilliancy is gone. On cutting into its substance, the inside is found to have lost all cohesion, being quite rotten. The only remedy in this case, is speedy amputation below the diseased part. Sometimes the force of the vital energy makes a stand as it were, against the encroaching disease, and throws off the infected joint or branch, just as we find the vital powers in animals overcoming the effects of mortification.

Etiolation. Plants are sometimes affected by a disease which entirely destroys their verdure, and renders them pale and sickly. This is called etiolation; and may arise merely from want of the agency of light, by which the extrication of oxygen is effected, and the leaf rendered green. And hence it is that plants placed in dark rooms, or between great masses of stone, or in the clefts of rocks, or under the shade of other trees, look always peculiarly pale. But if they are removed from such situations, and exposed to the action of light, they will again recover their green colour. Etiolation may also occur from the depredation of insects nestling in the radicle, and consuming the food of the plant; and thus debilitating the vessels of the leaf, so as to render them unsusceptible to the action of light. This is said to be often the case with the radicles of *secale cereale;* and the same circumstances may also arise from poverty of soil.

Suffocation. It occasionally happens that extraneous substances may so obstruct the pores of the epidermis, as to prevent the free exhalation of the juices, and thus produce the disease called suffocation. Sometimes it is caused by the accumulated growth of the lichens on the bark extending over the whole plant, as is seen frequently in fruit trees. If the young and succulent branches are thus coated, the proper functions of the bark are interrupted and decay, and death of the tree ultimately takes places. Fruit trees, on this account, should be carefully cleared of these parasites.

A similar effect is also produced by insects which feed on the sap or shoot. Thus the aphis or plant louse, accumulates in such myriads on tender shoots, as to exclude the air altogether, and consume the juices. The *coccus hesperidum,* and *acarus tellarius,* are parasitical insects, which infest hot-house plants, the latter by spinning a fine and delicate web over the leaf, and thus preventing the access of atmospheric air. Sometimes the disease is occasioned by an exudation of juices, which thicken on the surface of the stalk, so as to form a crust investing it as a sheath, and preventing its further expansion. Dr Keith writes that, on the 7th July, 1816, he observed some stalks of a grass partly enveloped with a crust, not unlike a piece of dried orange pill, particularly when viewed through the microscope. The part thus enveloped proved to be that in which the spike was yet contained within its sheathing leaves. The crust which thus totally locked up and suffocated the spike, extended from about one and a half to two inches in length, surmounted by the terminating leaf, whose base it also invested, thus giving to the grass the appearance of a typha in miniature. On examining this crust more minutely, it seemed to consist of thousands of yellowish globules, imbedded in a sort of ground resembling mortar. But in some species the crust was much paler, and not unlike the *boletus medulla-panis* in a recent state. It not only invested the outer leaf, but also the inner, though sheathed by the outer; and the spike, though sheathed by the inner leaf. The ear was so totally consumed, or so imperfectly formed, that the species of grass could not be ascertained till afterwards that a sound ear found showed it to be *holcus lanatus.* If this crust is not originally caused by the puncture of insects, it is at least selected as a fit nidus for depositing their eggs. For in looking at some specimens about a week after, several were found in which the surface of the crust was disfigured, with a sort of protuberant blister, which, when opened up, contained a maggot. And even in unsheathing, an ear which was thus locked up, and apparently inaccessible to insects, a small black fly occupied the interior. Sometimes the disease is occasioned from want of an adequate supply of nourishment, as derived from the soil in which the lower part of the plant is the best supplied, while the upper part is starved. Hence the top shoots decrease in size every succeeding year, because a sufficient supply of sap cannot be obtained to give them their proper development. This resembles what takes place in animal life, when the action of the heat becomes too feeble to propel the blood through the whole of the system, for then the extremities are the first to suffer. It may perhaps also account for the fact, that in bad soils, and unfavourable seasons, when the ear of barley is not wholly perfected; yet a few of the lower grains are always completely developed, which not only shows the superintending care of Providence for the preservation of the species, but points out also the efficient cause.

Contortion. The leaves of plants are often injured from the puncture of insects, so as to induce a sort of disease that discovers itself in the folding up or contortion of the margins, or wrinkled appearance of the surface. The leaves of the apricot, peach, and nectarine, are extremely

liable to be thus affected in the months of June and July. The leaf that has been punctured soon begins to assume a rough and wrinkled figure, and a reddish and scrofulous appearance, particularly on the upper surface. The margins roll inwards on the under side, and enclose the eggs which are scattered irregularly on the surface, giving it a blackish and granular appearance, but without materially injuring its health. In the vine, the substance deposited on the leaf is whitish, imparting to the under surface a frosted appearance; but not occasioning the red and scrofulous aspect of the upper surface of the leaf of the nectarine. In the poplar, the eggs, when first deposited, resemble a number of small and hoary vesicles, containing a sort of clear and colourless fluid; the leaf then becomes reflected and folded up, enclosing the eggs, and exhibits a few reddish protuberances on the upper surface. The embryo is nourished by the contained fluid, and the hoariness is converted into a fine cottony down, which for some time envelopes the young fly. The leaf of the lime tree in particular is liable to attacks from insects when fully expanded, and hence the gnawed appearance it so often exhibits. The injury seems to be occasioned by some species of *puceron*, depositing its eggs in the parynchema, generally about the angles that branch off from the midrib. A sort of down is produced, at first green, and afterwards hoary; sometimes in patches, and sometimes pervading the whole leaf, as in the case of the vine. Under this covering the eggs are hatched, and then the young insect gnaws and injures the leaf, leaving a hole or scar of a burnt or singed appearance. Sometimes the upper surface of the leaf is covered with clusters of wart-like substances. These seem to have their origin from a puncture made on the under surface, on which a number of openings are discoverable penetrating into the warts, which are rotten and villous within.

The punctures causing the gall-nuts are occasioned by insects chiefly of the genus *Cynips*. These punctures are made in some vigorous part of the plant, as the leaves, leaf stalks, young stem or branches; or more rarely in the calyx or germen. The parent insect deposits its egg there, which is soon hatched, and in consequence of the perpetual irritation occasioned by the young maggot feeding on the juices of the plant, the part where it is lodged acquires a morbid degree of luxuriance, frequently swelling to an immoderate size, and assuming the most extraordinary and whimsical shapes. This often happens to the shrubby species of hawkweed and *umbellatum*, whose stems in consequence swell into oval knots. Several different kinds of galls are borne by the oak, as those light spongy bodies as big as walnuts, commonly called oak apples: a red berry-like excrescence on its leaves, and the very astringent galls brought from the Levant for the purposes of dyeing and making ink, which last are produced by a species of oak different from the British. The common dog rose frequently bears large moss-like balls, in whose internal parts numerous maggots are always to be found, till they become the winged *cynips rosæ*, and eat their way out. Many willows bear round excrescences as large as peas, on their leaves. The mastic tree is often laden in the south of Europe with large red hollow finger-like bodies, swarming internally with small insects. The young shoots of *salvia pomifera*, and other species, in consequence of the attacks probably of some cynips, swell into large juicy balls very like apples, and even crowned with rudiments of leaves resembling the calyx of that fruit. These are esteemed in the Levant for their aromatic and acid flavour, especially when prepared with sugar. It may be remarked that all these excrescences are more acid than the plant which bears them, and also generally inclined to turn red; the acid is partly the acetous.

Consumption. This consists in a gradual decrease of the energy of the vegetable functions, till at last decay and death occurs, and may arise from a barren or unfavourable soil, from climate, careless planting, or too frequent blossoming exhausting the strength of the plant. Excess in drought, or dust lodging on the leaves, or the fumes of deleterious matters floating in the atmosphere of manufactories, occasions the same decay, and not unfrequently the attacks of numerous minute insects.

There is a malady which frequently attacks the pine tree, called *teredo pinorum*, which seizes on the alburnum and inner bark chiefly, and seems to proceed from long-continued drought, or from frost suddenly succeeding mild or warm weather, or heavy winds. The leaves assume a tinge of yellow bordering on red, a great number of small drops of resin exude from the middle of the boughs, of a putrid odour, the bark peels off, and the alburnum presents a livid appearance. The tree swarms with insects, and the disease is incurable, inducing inevitably the total decay and death of the individual.

Natural decay. We have thus enumerated the principal diseases to which plants are liable, whether from external injuries, or internal derangement of structure in functions. Yet though a plant should escape all these, still a period will arrive when its several organs will begin to experience the approaches of a natural decay, the vital energies will at last cease to act, and the plant will moulder into its component elements. We thus find that in the vegetable, as well as the animal kingdom, there is a limit or term set beyond which the individual cannot pass, although the period of existence varies as much

among the various classes and species of vegetables as among animals. Thus some plants are annuals, and last for one season only, springing up suddenly from seed, coming rapidly to maturity, reproducing other seeds, and scattering them abroad into the soil, and after this immediately perishing. Such is the case with the various kinds of corn, as oats, wheat, and barley. Some plants continue to live for a period of two years, and are therefore called biennials, springing up the first year from seed, and producing root and leaves, but no fruit; and in the second year producing both flower and fruit, as the carrot, parsnip, carroway. Other plants are perennial, lasting for many years, of which some are called under shrubs, and die down to the root every year; others are called shrubs, and are permanent both by the root and stem, but do not attain to a great height or great age; others are called trees, and are not only permanent by both root and stem, but attain to a great size, and live to a great age. The oak, in particular, is remarkable for its size and longevity, taking at least one hundred years to attain its full growth, and continuing vigorous for one or two hundred years more before falling to decay. But even of plants that are woody and perennial, there are parts which perish annually, or which are, at least, annually separated from the individual, such as the leaves, flowers, and fruit, leaving nothing behind but the bare caudex, which submits in its turn to the ravages of time. Hence we shall consider first the decay of the temporary organs, and next the permanent organs, and consequent death of the whole plant.

The decay of the temporary organs, which takes place annually, is a circumstance familiar to every one, and comprehends the fall of the leaf, the fall of the flower, and of the fruit. The fall of the leaf commences in most plants in this climate with the first chill of autumn, and is accelerated by the frosts of the coming winter, that strip the forests of their foliage, and the face of nature of its green verdure. Yet there are some trees that retain their foliage throughout the whole winter, though changed to a dull and dusky brown, as the beech tree and others, that retain them in full verdure till the ensuing spring, when they ultimately fall. These latter are known as evergreens. It was at one time, indeed, a common error, and perhaps it continues to be so to some extent still, that evergreens never part with their leaves. This error may be traced back even to the period of the fabulous history of the Greeks, with whose mythology it was closely interwoven, at least in one particular example, as related by Theophrastus, who says that in the country of Cortynia in Crete, it was reported there was a plane tree growing by a fountain which never shed its leaves, being the tree under the shade of which Jupiter is said to have had his interview with Europa. But Theophrastus was himself acquainted with the fact of the fall of the leaves of evergreens, as every accurate observer of nature must be, though they do not actually fall till the young leaves have begun to appear, so that trees of this sort are never left wholly without leaves, which it was hence supposed they never shed. In warm climates it is said that many plants retain their leaves for several years; but in temperate and polar climates there are no such plants to be found.

Such is the fact of the annual fall of the leaves. But the cause of their fall has been an inquiry which has baffled the attempts of the botanist to explain. Du Hamel minutely considered this subject without arriving at any very definite conclusion. He observed that leaves which fall the soonest transpire the most, and are consequently the soonest exhausted, and rendered unfit to discharge their functions, so that the period of the fall of the leaves of different species is probably in proportion to their capacity for transpiration. Their fall is accelerated by frost or excessive heat, followed by rain. It is also accelerated, if not actually induced, by the structure of the pedicle, which is very different from that of the branch, having no prolongation of pith, and nothing analogous in its mode of insertion, nor in its external figure, which is divisible into an upper and under surface, resembling the figure of the leaf. He compares the union of the leaf and stem to that of the joints of the lime twig, which, at a certain period of its growth, are stronger than its internodia, but which really give way after a frost. The comparison, however, throws but little light on the subject, as the illustration is itself to the full as dark as the thing to be illustrated; but he offers an additional conjecture, which is considerably more luminous. When the sap begins to flow less plentifully, the leaves, to whose vigour a great supply is necessary, soon become dry, and consequently less fit to convey it. But it is known that the branches grow in thickness after they have ceased to grow in length, which must necessarily occasion, in some degree, a disruption of the fibres of the foot stalk and stem, a branch at the point of articulation, and hence the leaf loses its hold and falls. This is certainly a very plausible conjecture, though it may be doubted whether this explication will apply to the case of evergreens or of plants in warm climates, that retain their leaves for several years. It is not, therefore, altogether satisfactory, and hence, accordingly, other explanations have been offered. That of Willdenow is as follows: As the sap is conveyed to the leaves in greater abundance during the summer, the vessels of the petiola become gradually more woody, as well as the whole of the leaf. The sap consequently stagnates, and at last the bond of union between the leaf and stem is dried up

and cracks. The wound that the stem thus receives cicatrizes before the petiola separates, and the petiola separates at last in consequence of the interrupted connection between the leaf and stem which the crack has occasioned. This, it must be confessed, does not make up for the deficiencies of the hypothesis of Du Hamel; for in the first place, there is no proof that the bond of union between the leaf and stem cracks in the manner here supposed; and even upon the supposition of its being the fact, it is, in the second place, extremely improbable that the petiola should, after the cracking of this bond of union, still continue attached to the stem till the wound thus occasioned has cicatrized, because, when the original bond of union cracks, there remains no other attachment by which the petiola is to retain its hold. Willdenow quotes another explanation by Vorlick: The leaf, which possesses a peculiar vitality within itself, though dependent upon the vitality of the plant, and generally of shorter duration, dies when it reaches maturity; and the plant being able to exist, for a time, without leaves, throws off the dead leaf, as the animal throws off the dead part from the sound part. But the peculiar vitality which the leaf is here supposed to possess seems to me, says Dr Keith, to be altogether a groundless assumption, and an unphilosophical multiplication of causes without any apparent necessity. Is it not rather the individual vitality of the plant extended to a perishable organ, and again withdrawn when that organ has discharged its destined functions, or become, by disease or decay, unfit for the purposes of vegetation? This is perhaps a better founded supposition than the former, though the reference to the phenomenon of the throwing off of the dead part from the sound in the animal subject, is sufficiently well adapted to the purposes of illustration, and the analogy sufficiently striking, at least under some of its aspects, to warrant its introduction; for which, or for similar reasons, Sir J. E. Smith gives his sanction to the opinion of Vorlick, which he had himself indeed been previously led to adopt, though he was anticipated in the publication. The notion was first suggested to him by some remarks of Mr Fairburn of Chelsea, who had observed that, in the transplanting of trees, if the injury extends suddenly beyond the leaf, then the leaf remains firmly attached to the twig, even though dead; but when the leaves alone are affected, and the vital energy acting with full force in the branch, the leaves are thrown off, or fall on the slightest touch; hence Sir J. E. Smith concludes that leaves are thrown off by a process similar to that of the sloughing of discarded parts in the animal economy. It does not, however, seem quite evident to me, continues Dr Keith, that the idea of sloughing is comprehended in the opinion of Vorlick. Sloughing in the animal economy is the exertion of that power by which the vital energy is capable of throwing off a part that has accidentally become diseased, and unfit for discharging the functions to which it was originally destined, but not that power by which it is capable of throwing off a distinct organ, intended by nature to be finally separated from the individual. Now, in the case of the disfoliation of the plant, there is, for the most part, no disease, but merely a gradual and natural decay, which reduces the leaf to a state indeed no longer fit for the purposes of vegetation, but to which it was intended by nature to be reduced, for the purpose of facilitating its separation from the plant; and hence it always separates in a determinate manner, and at a determinate point, namely, at the base of the foot stalk, which forms as it were a sort of natural joint, to which there is nothing analogous in the case of sloughing. If this were not the fact, it might be expected that a part of a leaf, or even the whole of it, should occasionally become permanent as well as the branches, though no such thing has ever yet happened. In the sloughing of the diseased part there is yet another circumstance coinciding with the analogy that is here instituted. The part supplying the place of the slough, on throwing it off, is formed, or exists already formed, immediately beneath it, and is precisely of the same character with what the slough originally was, which slough it pushes off as it comes itself to maturity, or acquires strength sufficient for the effort. But the leaves fall off, when they have reached maturity, of their own accord, without being at all pushed off by the new ones, which are yet merely in embryo, and do not even occupy the place of the old leaves, but are only formed contiguous to them, except in the case of the plane tree, the new leaf of which is formed precisely under the base of the foot stalk of the old leaf; and yet we would not call the fall of that leaf sloughing, because the new leaf does not after all push off the old one, and because there is here, as in other cases, the same natural articulation uniting the leaf to the branch or stem, and rendering it a distinct organ, that is ultimately and spontaneously to detach itself from the plant. Not that there exists no example whatever of vegetable sloughing, which the same tree will also furnish, in the annual, or rather continual, exfoliation of its bark; but that the fall of the leaf does not seem to afford that example. I can see an objection, adds Dr Keith, that may be urged against the above argument, from the fact of the sloughing of the actual skin of the snake and other species of serpents, which may be regarded as a distinct organ. But although the skin of the snake, or of any other animal, may be regarded as a distinct organ, yet it must be in a light very different from that of an organ attached to the body of a plant or animal by a natural joint or

articulation, that comes asunder of its own accord, for the skin of the animal in question is forced off, in the manner of a slough, merely by means of the formation of a new skin beneath it, which has already taken the place of the old skin in the living system, and to which it has just been shown that there exists nothing whatever analogous in the fall of the leaf; so that, after all, the best reason we can give is, perhaps, that the leaves fall in consequence of their being worn out, and no longer necessary to the immediate process of vegetation, which is evidently divisible into annual stages, commencing with the approach of spring, and terminating with the return of winter, which is to the vital principle apparently a period of rest. If it is necessary, however, to attempt an explanation of the process by which the leaf is made ultimately to detach itself from the plant, it may be observed, that it consists wholly in the change that is effected in the articulation uniting the foot stalk to the branch, as is evident from the remarks of Mr Fairburn; for in the case in which the injury extends suddenly beyond the leaf, the leaf may wither and decay, but will not fall off, because the articulation has not been duly prepared, and because the vital energy can now no longer act upon it from the intervention of the dead or diseased portion of the plant, beyond which it has withdrawn itself. But in the natural process of vegetation the necessary change is effected by the leaf on the one hand, in its yielding to the influence of physical or chemical agencies, and withering and shrinking into narrower compass when the usual supply of sap is no longer transmitted to it, and by the vital energy on the other, in its controlling and dividing of chemical agencies, so as to facilitate the final detachment of the foot stalk, and form the scar necessary to its own protection. And this effect is brought about by the conversion of the substance that cements the respective fibres of the leaf, stalk, and branch together, from a soft and glutinous to a dry and brittle consistence, analogous to the change that takes place in the seams of the valves of ripening capsules or pericarps, so that the leaf falls at last merely by force of its own weight, or of the slightest breath of wind, but without the intervention of any previous chink or crack. If it be necessary to illustrate the fall of the leaf by any analogous process in the animal economy, it may be compared to that of the shedding of the antlers of the stag, or of the hair or feathers of animals, which being, like the leaves of plants, distinct and peculiar organs, fall off, and are annually renewed, but do not slough.

The flowers which, like the leaves, are only temporary organs, are for the most part very short lived; for as the object of their production is merely that of effecting the impregnation of the germs, that object is no sooner attained than they begin again to give indications of decay, and speedily fall from the plant, so that the most beautiful part of the vegetable is also the most transient. The flower of the night-blowing cereus, the most magnificent of all flowers, no sooner expands than it begins to decay, and before the sun has risen upon it its beauty is gone. The flowers of the poppy and tulip, though very gaudy, are very short lived, and the beautiful blossom of our fruit trees soon begins to fade. The scene often continues beautiful indeed, both in the landscape of nature and of art; but that is more owing to the succession of blossoms on the same or on different plants, than to the permanency of individual blossoms. And so also of the flowers that adorn the fields or meadows; they spring up in perpetual succession, but are individually of very short duration.

The fruit which begins to appear conspicuous when the flower falls, expands and increases in volume, and assuming a peculiar hue as it ripens, ultimately detaches itself from the parent plant, and drops into the soil. But it does not, in all cases, detach itself in the same manner; thus in the bean and pea, the seed vessel opens and lets the seeds fall out; while in the apple, pear, and cherry, the fruit falls entire, enclosing the seed which escapes when the pericarp decays. Most fruits fall soon after ripening, as the cherry and apricot, if not gathered; but some remain long attached to the parent plant after being fully ripe, as in the case of the fruit of *cratægus* and *uœnymus*, which may be seen in the hedges in the midst of winter; and of *mespilus*, which continues till the succeeding spring. But these, though tenacious of their hold, detach themselves at last as well as all others, and bury themselves in the soil about to give birth to new individuals in the germination of the seed. The fall of the flower and fruit is accounted for in the same manner as that of the leaf.

Such then is the process and probable cause of the decay and detachment of the temporary organs of the plant. But there is also a period beyond which even the permanent organs themselves can no longer carry on the process of vegetation. Plants are affected by the infirmities of old age as well as animals, and are found to exhibit similar symptoms of approaching dissolution. The root refuses to imbibe the nourishment afforded by the soil; or if it does imbibe a portion, it is but feebly propelled, and partially distributed through the tubes of the alburnum; the elaboration of the sap is now affected with difficulty, as well as the assimilation of the proper juice, the descent of which is almost totally obstructed: the bark becomes thick and woody, and covered with moss or lichens; the shoot becomes stunted or diminutive; and the fruits palpably degenerate both in quan-

tity and quality. The terminal or smaller branches first fade and decay, and then the larger branches, together with the trunk and root. The vegetative energies gradually decline, and at last totally cease. At last the whole solid mass of the plant, acted on by the surrounding elements, moulders down and mingles with the dust from which it originally sprang. Such is at last the fate of the aged oak, as well as the fragil weed; each has its allotted span; but in the present state of physiological knowledge, it would be utterly vain to attempt a solution of the mysterious cause.

CHAP. XXI.

VEGETABLE PRODUCTS.

The simple or elementary substances which enter into the composition of all vegetables, are, as we have already shown, confined to a very small number. Oxygen, hydrogen, nitrogen, carbon, lime, silex, alumina, magnesia, potash, soda, iron, forming the greater part of the list. Plants, however, are endowed with the powers of assimilating and combining these various substances into compounds, assuming various forms and properties. The chief of these vegetable compounds are gum, sugar, farina or starch, gluten, albumen, fibrina, extract, tannin, colouring matter, bitter principle, narcotic principle, alcohol, acids, oils, wax, resins, gum resins, balsams, camphor, caoutchouc, cork, lignin or woody fibre, sap, proper juice; while the simple or uncombined products are carbon or charcoal, the mineral alkalies, earthy and metallic oxides.

Gum. This is a substance which flows spontaneously from the bark and leaves of many plants. It is at first a viscid, transparent, and tasteless fluid; and, on exposure to the atmosphere, gradually solidifies into a mass. Gum is produced abundantly from many of our fruit trees, especially those which have stone kernels, as the cherry and plum. It flows from fissures in the bark, and sometimes from the fruit itself. Some plants do not discharge it spontaneously; but from those it may be extracted by maceration in water. There are several varieties of gum, known under the name of gum Arabic, gum tragacanth, cherry tree gum, and mucilage.

Gum Arabic is obtained from the *mimosa nilotica*, a native of the interior of Africa, and of Arabia, from whence it has obtained its name. Gum Senegal, an exactly similar gum, is procured from *acacia verek*. It comes to this country in irregular globules, or masses; is hard, brittle, and when pure almost colourless, or of a slight straw-colour, and transparent. It readily dissolves in water, forming an adhesive and emollient mucilage; and if left exposed to the air will again soon form into a hard mass, in the evaporation of the water. It is insoluble in alcohol.

By chemical analysis, 100 parts of gum Arabic contain the following elementary matters:

Carbon	42.23
Oxygen	50.84
Hydrogen	6.93
Saline and earthy matter, a small quantity.	

Gum tragacanth. This substance is obtained from *astragalus tragacantha*, a thorny shrub, which grows abundantly in the islands of the Levant. The gum exudes spontaneously from the stem and branches. In appearance, it resembles gum Arabic, and is similar to it in its other properties, though less transparent, and less soluble in water. It comes to this country in thin twisted plates or cakes.

Cherry tree gum, is obtained from the *prunus avium*, and other similar species, and indeed, from all trees bearing stone fruits, from the bark of which it spontaneously flows. It is in all essential points of similar properties to the foregoing gums; but rather more easily melted by heat. This gum contains a peculiar substance, called *cerasin*. Mucilage is found in the roots and leaves of bulbous rooted and succulent plants, such as the bulbs of the hyacinth, and leaves of the marshmallow, (*malva sylvestris;*) it is found also abundantly in lintseed, and in several other oily seeds. It may be extracted also from many of the lichens by maceration in water, and separated by the addition of sulphuric acid.

Gum and mucilage, though insipid to the taste, contain highly nutritive qualities and form a useful diet in some kinds of diseases and particular states of the digestive organs. Gums are also externally used in the arts, particularly in calico printing, in which the printers use them to give consistency to their colours, and to prevent their spreading on the cloth. Gums are used as convenient adhesive fluids for pasting substances together. A simple solution of gum in water, with the addition of a little spirit of lavender, to prevent the acetous fermentation, is the most convenient for all purposes of this kind. Gum also gives thickness to ink, and promotes the intimate mixture of its particles. In medicine it is also used extensively.

Sugar. This important article is found in the juices of a great many vegetables, but in greatest abundance in the sugar cane, (*arunda sacchari-fera*,) from which the sugar of commerce is manufactured. This cane, when it has arrived at its proper state of maturity, is found to be full of a sweet juice. In this state it is taken and bruised between the rollers of a mill, the

expressed juice is collected and put into boilers, and mixed with a proportion of lime, to absorb the excess of acid; then it is boiled for some time, care being taken to clear away the scum, which accumulates on the top. When the boiling has been continued sufficiently long to convert the juice into a thickish syrup, it is drawn off, and placed in shallow vessels to cool. The thinner part, or the molasses being drawn off by small holes, a mass of crystallized sugar remains. This is the raw sugar of commerce, which has a brown colour and peculiar odour; when further purified it becomes the white or loaf-sugar. Thus obtained, it has a sweet luscious taste, but no smell: when perfectly pure it is white, and somewhat transparent. On exposure to a moist atmosphere, it absorbs moisture; but is not otherwise altered. It is very soluble in water, boiling water dissolving its own weight of sugar. It is soluble in alcohol, and in the acids, though in a less degree. Concentrated acids are capable of decomposing it. Its elementary composition consists of

Oxygen	64.7
Hydrogen	7.8
Carbon	27.5
	100.

Many other plants contain also a large proportion of sugar. The American maple (*acer saccharinum,*) at particular seasons of the year, affords a juice highly saccharine. For the purpose of manufacturing sugar, early in spring a slanting hole is bored in the trunk of the tree, and the juice is collected in pitchers. A tree of ordinary size, will yield from 150 to 200 pints of juice in the season. This juice is mixed with lime, and boiled; when after due evaporation, crystals of sugar are deposited in the proportion of about 1 lb. sugar to 40 pints of sap. The sugar in its qualities nearly resembles that procured from the sugar-cane. Grapes also yield a sugar when treated with potash; but owing to the quantity of acid in the fruit, its taste is not found very agreeable. Common beet root, (*beta vulgaris*) also yields a large quantity of saccharine juice, which, by skilful manufacture, can be made into very good sugar; and during the war with Britain, this manufacture was extensively cultivated in France, by the express commands of Bonaparte, who strictly excluded all products of British colonial importation. Sugar has also been procured from many other plants; from the birch tree, sycamore, bamboo, maise, American aloe, cocoa nut, and walnut; from the roots of the parsnip, carrot, turnip, cow parsnip, and from the nectaries of most flowering plants. The farina of wheat and potatoes, when treated with concentrated sulphuric acid, will also yield a saccharine product.

Sugar is highly esteemed as an article of food not only by man but by most animals. Bees extract it from the nectaries of plants, and store it up in cells where it becomes honey. Besides being highly grateful to the palate, it is found to be a nutritious food; but perhaps more so when combined in the natural state in vegetables, than when highly concentrated and refined by the art of man. It was at one time, especially in the form of honey much used in medicine; but has now been found to possess no medicinal virtues, its use being confined to a vehicle for the exhibition of more active drugs.

Farina or *Starch.* This substance exists in the seeds and bulbs of many vegetables, and may be readily obtained by taking a quantity of wheaten flower, and kneading it under the flow of a stream of water. When the kneading has proceeded so far that the water is no longer tinged of a white colour, this water is allowed to settle, and in a few hours a pure white mass will be found at the bottom, which, when dried and powdered, becomes starch. This substance may also be procured by grinding down potatoes in a quantity of water, allowing time for the starch to subside to the bottom, and then pouring off the other matters above. Starch is, in its dry state, a fine white powder, tasteless and inodorous. It is only partially soluble in cold water, and forms with it a white emulsion; with boiling water, it forms a thick and tenaceous paste. If thrown upon a plate of red hot iron, it burns with a slight explosion, leaving scarcely any residuum behind. Its component elements are,

Carbon	43.55
Oxygen	49.68
Hydrogen	6.77
	100.

On reverting to the analysis of sugar, it will be seen how very nearly both substances coincide in their composition; and, indeed, starch may be converted into sugar by diminishing the proportion of carbon, and augmenting that of oxygen and hydrogen. This may be done artificially, by the addition of an acid, as the sulphuric; and is exemplified in the germination of seeds, especially in the conversion of barley into malt. This grain contains a great proportion of starch, which, absorbing oxygen in the germinating process, and giving out carbonic acid, is finally converted into sugar. Potatoes also, if exposed to a degree of cold that destroys their vital energy, immediately undergo a fermentation, and their starch is converted into sugar. Starch is also obtained from the pith of several species of palms of the Molucca and other East Indian islands. For this purpose, the stems of such palms are cut into longitudinal pieces of six feet in length, so as to expose their pith, which is

taken out, pounded, and mixed with cold water. After a few hours the starch collects as a sediment at the bottom of the vessel, and the fluid above is poured off. This is the *sago* of the shops. The roots of the orchis tribe afford a starch called *salop* and *cassava;* it is prepared from the root of the poisonous *Jatropha manchot*, a native of America. The husks of oats also, treated by maceration in water, afford a starch which in Scotland is used as an article of food called sowins. Parmentier enumerates a list of plants, from the roots of which starch may be made, among which are the following:

Arctium lappa	Imperatoria ostruthium
Atropa belladonna	Hyosciamus niger
Colchicum antumnale	Rumex obtusifolius
Spiræa filipendula	——— acutus
Ranunculus bulbosus	——— aquaticus
Scrophularia nodosa	Arum maculatum
Sambucus cæruleus	Iris pseudacorus
——— niger	——fœtidissima
Orchis moria	Orobus tuberosus
——— mascula	Bunium bulbocastaneum

Starch is also found in the following seeds:

Wheat	Chestnut
Barley	Horse-chestnut
Oats	Peas
Rice	Beans
Maise	Acorns
Millet seed	

Various other substances somewhat similar to starch have been discovered by chemists, such as *hordein* from barley, and *lichnein* from Iceland moss. Starch is one of the ingredients of all food derived from vegetable grains, grasses, &c.; and forms a nutritive diet both for man and many animals. The latter feed upon it in that state in which nature presents it; but man prepares and cooks it so as to render it pleasing to his taste, and more easily assimilated into his system. In the arts starch is used to a considerable extent, in stiffening linen goods, and preparing them for taking on or rejecting particular dyes. Wafers are also made of paste, and many trinkets and ornaments.

Gluten. That portion of the flower of wheat which remains insoluble after the application of water in making starch, is called gluten. It is of a dull, white, or brown colour, tough, elastic, tasteless but possessed of a peculiar faint smell. It is soluble in the acids and alkalis; but insoluble in water and alcohol. When exposed to the atmosphere it becomes hard and tough, assumes a dark brown colour, with a slight degree of transparency, resembling animal glue; but it is brittle, and breaks like a piece of glass. When kept in a damp situation it undergoes a kind of fermentation, in which it swells and emits air bubbles, consisting of hydrogen and carbonic acid gas. When exposed in a dry state to heat, it cracks, swells, and melts, and exhales a fetid odour, burning like horns or feathers. When distilled it yields ammonia and an empyreumatic oil, and leaves a charcoal that is with difficulty reduced to ashes. Gluten, then, in many of its characteristics, resembles closely animal jelly, particularly in its fermentation and destructive distillation, and in its containing a portion of nitrogen. Gluten is found in a great proportion of vegetable substances, as well as in wheat. Rowelle found it existing in the green fecula of plants; and •Proust detected it in peas, beans, barley, rye, acorns, chestnuts, horse-chestnuts, apples, quinces, elder-berries, grapes; in the leaves of rue, cabbage, cresses, hemlock, borage, saffron, and in the petals of the rose. As regards the food of man it seems one of the most important of vegetable products, especially in the formation of wheaten bread, the great staple of life. It is also used in forming cements, and as a ground for varnishing. Gluten has been resolved by chemists into four distinct principles: *albumen*, *emulsion*, *mucin*, and *gluten.*

Albumen. Animal albumen is a glairy, tasteless fluid, exemplified in the white of an egg. Its existence, in vegetables, was first announced by Fourcroy, and afterwards confirmed by Vauquelin, who pointed it out on the dried juice of the papan tree, a plant indigenous to India and the isle of France. A specimen of this juice, which often exudes from the tree, in a viscid and milky state, was brought to Paris by Charparbier after being evaporated to dryness, and presented to Vauquelin. It was somewhat yellowish and semi-transparent, and its taste was sweetish; but it had no smell. When it was subjected to maceration in cold water, the greater part of it was dissolved. The solution frothed with soap, and was coagulated, and rendered white by the addition of nitric acid. When boiled it precipitated white flakes, which were coagulated albumen, possessing all the properties by which it is distinguished in animals; disengaging ammonia, by burning and yielding at the same time carbonic acid and water. And hence its relation to animal gluten is established, and the elements of its composition ascertained, which are as follows:

Carbon	52.883
Oxygen	23.872
Hydrogen	7.540
Nitrogen	15.705

Albumen has not been found in such abundance in any other plant as in that just alluded to. But it has been ascertained to exist in mushrooms, and some other of the fungi; and the juice of the fruit of *hibiscus esculentus*, a West Indian plant, is said to contain such a proportion of it as to render it fit to be employed as a substitute for the white of eggs in clarifying

the juice of the sugar cane. Almonds also, and other kernels, from which emulsions are made, have been found to contain a substance possessing the properties of curd, which resembles albumen very closely.

Fibrine. A substance somewhat like the fibrine of the animal flesh, or muscular parts, was detected in the juice of the papau tree, by Vauquelin. When the inspissated juice of this tree was subjected to maceration in water, the greater part of it was dissolved; but there remained a portion that was insoluble. It had a greasy appearance, and became soft and viscid upon exposure to air, assuming a brown colour, with a slight degree of transparency. When thrown upon ignited charcoal it melted, exuding drops of grease, accompanied with a noise like that of meat roasting, and producing smoke which had the odour of volatilized fat. It left no residuum. This substance was vegetable fibrine, possessing the properties of the fibrine of animals.

Extract. Vegetable substances, when macerated in water, dissolve; and if the water is evaporated, a residuum remains, which is called vegetable extract. As vegetables differ considerably, however, according to the families to which they belong, and to the nature of the soil and climate in which they have grown, it is obvious that this extract must also vary according to the plants which have been employed in its production. It was necessary, therefore, for the purposes of chemical accuracy, to endeavour to ascertain whether there existed in extracts any peculiar and definite principle, independent of such accidental ingredients as have been now alluded to; and which might itself be regarded as the true extractive principle. With this view, Vauquelin commenced a series of experiments chiefly upon the sap and expressed juices of plants, during the process of which he remarked that they always began to acquire a darker shade of colour from the moment they were exposed to the air; and that during the evaporation a brown or reddish pellicle was formed on the surface, which afterwards broke into flakes and remained insoluble. Similar appearances were observed in medicinal extracts, and the longer the evaporation was continued the more of the insoluble flakes were formed. This was accordingly regarded as a detection of the true extractive principle; and the formation of the pellicle and flakes was found to be the result of its absorption of a portion of the atmosphere, to which it was thus found to have a strong affinity. This extract, then, is thus distinguished. It is soluble in water when directly obtained from the vegetable, but becomes afterwards insoluble in consequence of the absorption of oxygen from the atmosphere. It is soluble in alcohol, and unites with alkalies, forming compounds which are soluble in water. When distilled it yields an acid fluid, impregnated with ammonia, and seems to be composed chiefly of hydrogen, oxygen, carbon, and a little nitrogen. This extractive matter is found in greater or less quantity in all plants, and is very generally an ingredient of the sap and bark, particularly in barks of an astringent taste; but yet it is not exactly the same in all plants, even when separated from all impurities. Several different kinds of extract, then, are distinguishable.

Extract of catechu is obtained from an infusion of the interior wood of the mimosa catechu. It is of a brown colour, and very astringent, and hence used as an astringent and tonic in medicine.

Extract of senna is got from an infusion of the dried leaves of *cassia senna* in alcohol; it is of a brown colour, bitter, and slightly aromatic.

Extract of Quinquina was obtained by Fourcroy, by evaporating an alcoholic solution of the bark of the *quinquina* tree. It is of a brown colour and bitter taste; soluble in boiling water, though insoluble in cold.

Extract of saffron is obtained from the summits of the pistils of the *crocus sativus.*

Many other extracts might be enumerated which were formerly much used in medicine, though now their efficacy is not so much depended upon as preparations of the substances from whence they were derived. Vegetable extracts are, however, extensively used in the arts, especially for the purpose of dyeing cloths and silks.

Colouring Matter. Nothing can exceed the beauty and delicacy of the tints of flowers; and though these have been the admiration of all ages, yet the nature of the colouring principle is not yet by any means well understood. Chemists, however, have endeavoured to isolate this colouring matter, and to investigate its nature. It seems to have a great affinity for oxygen, the earthy alkalies, and metallic oxides, as also for cloths made of vegetable fibre or animal wools. This affinity seems stronger for the latter than the former, and hence wool and silk assume a deeper dye, and retain it longer than cotton or linen. Colouring matter exhibits a great variety of tints, as it occurs in different species of plants, and as it is combined with the oxygen of the atmosphere it assumes a deeper shade; but it loses, at the same time, a portion of its hydrogen, and becomes insoluble in water, thus indicating its relation to extract.

The fundamental colours used in the art of dyeing are blue, red, yellow, and brown. The finest of all vegetable blues is that which is known by the name of indigo. It is procured from a shrub which is cultivated in Mexico and in the West Indies, the *Indigofera tinctoria* of Linnæus. The plant arrives at maturity in about six

months, when its leaves are gathered, and immersed in vessels filled with water till fermentation takes place. The water then becomes opaque and green, exhaling an odour like that of volatile alkali, and evolving bubbles of carbonic acid gas. When the fermentation has been continued long enough, the liquor is decanted and put into other vessels, where it is agitated till blue flakes begin to appear. Water is now poured in, and the flakes are precipitated in the form of a blue powdery sediment, which is obtained by decantation; and which, after being made up into small lumps, and dried in the shade, forms the indigo of commerce. It is insoluble in water, though slightly soluble in alcohol; but its true solvent is sulphuric acid, with which it forms a fine blue dye, known as liquid blue. Several other plants also yield indigo, and particularly the *isatis tinctoria*, or woad, a plant indigenous to Britain, and thought to be the plant with the juice of which the ancient Britons stained their naked bodies, to make them look terrible to their enemies. If this plant is digested in alcohol, and the solution evaporated, white crystalline grains, somewhat resembling starch, will be left behind, which grains are indigo, and they will become gradually blue by the action of the atmosphere. The blue colour of indigo, therefore, is owing to its combination with oxygen. *Litmus*, or turnsole, is procured from a species of lichen, *lecinora tartarea*, found chiefly in Norway. These lichens are cleaned and powdered, and mixed with putrid urine. The ammonia of the urine acts on the powder, and a fermentation is produced, and a blue colour is developed. Acids, even of the weakest kind, redden this blue very readily; and hence paper stained with litmus is a frequent test of the presence of acids.

A red colour is produced from the root, stem, or flower, of the five following plants: 1st. From the roots and stems of *rubia tinctorum*, or madder, dried, bruised, and sifted, a powder is obtained, that is soluble in alcohol, and partly soluble in water, and dyes cloth, by means of proper mordaunts, either violet or red. The red colour is very beautiful. This powder not only tinges vegetable matters, but will communicate a red hue to the bones of animals, if mixed with their food. 2d. From two species of lichens (*lichen roccella* and *parellus*), when dried, powdered, macerated in water, and mixed with a solution of muriate of tin, a fine red dye is obtained, which, however, is very evanescent on ordinary articles, though more permanent on marble, which it stains of a deep violet. 3d. From the flowers of the *carthamus tinctorius*, on the addition of an alkali, a red extract is obtained, which is precipitated by acids, and forms the beautiful powder called carmine, or rouge. 4. Brazil wood, obtained from the *Cesalpina crista*, furnishes, with the addition of alum, a red powder, which dyes stuffs, and affords the lake used in water colours. 5. A red colouring matter is obtained from *hematoxylon Campechianum*, or Campechy wood, nearly resembling Brazil wood, except that its shade is somewhat deeper, and more permanent; much used in silk dyeing. *Cudbear*, a substance extracted from several species of lichens, affords a beautiful purple dye. Red sanders wood is soluble in alcohol, and imparts a deep crimson to the fluid.

Yellow, a very general vegetable colour, is procured from several plants. The *resida cuteola* of Linnæus yields a yellow by boiling its dried stems, and precipitating with alum. This matter is much used in the dyeing of silks, cottons, and wool. The *morus tinctoria*, a native of the West India islands, also yields a yellow dye, by decoction of its wood and the addition of the acid. If the bruised seeds of the *bixa orellana* are made into a paste with a little oil, and boiled in water, a solution of alum will throw down a yellow powder, well known as anotto. Several other plants yield a yellow dye, as *serratula tinctoria*, *genista tinctoria*, *rhus cotinus*, and *rhamnus infectorius*. Turmeric is the prepared root of the *curcuma longa*, a plant which is a native of the East Indies. Saffron is a yellow dye obtained from the petals of the *crocus sativus*, extensively cultivated in Cambridgeshire. *Sumac* is obtained from the dried and powdered branches of the *rhus coriaria*, a shrub indigenous to Italy and the south of France, where it is cultivated for dying yellow, and for tanning leathers.

A brown colour is produced from a great many vegetables, especially those of an astringent character. It is obtained from the root of the walnut tree and rind of the walnut, from the elder tree and oak, and especially from nutgalls. These last are procured from a species of oak, indigenous to the south of Europe. If a decoction of powdered galls be added to a solution of sulphate of iron, a deep black is produced, much used as a dye, and also with the addition of a little gum arabic, forming the common writing ink.

Though green is the universal livery of vegetable nature, yet there is no distinct principle which can be used as a green dye. Green is in fact a compound colour, and is always formed by dying substances first yellow and then blue. The green matter of the leaves of plants has been called *chromalite*. Sap green is the inspissated juice of the half-ripe berries of buckthorn, (*rhamnus catharticus*) a plant which grows wild in Britain, and other parts of Europe. Alkalies change this sap green into yellow.

Tannin. If a quantity of pounded nut galls or bruised seeds of the grape, be taken and dissolved in cold water, and the solution evaporated to dryness, there will be left behind a brittle and yellowish substance of a highly astringent taste,

which is tannin. Pure tannin is colourless, its taste is excessively astringent, without bitterness. It has no smell, water dissolves it freely, and the solution reddens paper stained with litmus. It decomposes the alkalies with effervescence, forms with most of the metallic solutions a precipitate, and with the salts of iron a deep black ink.

When tannin is distilled it yields charcoal, carbonic acid, and inflammable gases, with a minute quantity of volatile alkali, and seems accordingly to consist of the same elements as extract; from which, however, it is distinguished by the peculiar property of its action upon gelatine.

Gall nuts were known to the ancients, and were employed by them in medicine; but they seem to have had no accurate idea of their origin, as they considered them to be the fruit of the oak. They are now ascertained to be the nidus or nest of the young of the *cynips gallæ tinctoriæ*, and of the *cynips quercus foliæ*, insects which live on the oak.

Proust was the first chemist who procured tannin from galls in a separate state, and who accurately described its properties. Chemists have since enumerated several varieties of it. The purest kind is that obtained from the seeds of the grape. It forms a white precipitate with the solution of isinglass, and in most of its qualities resembles the tannin of nut galls. Catechu contains another kind; its precipitate by gelatine has a brown colour. The substance known under the name of dragon's blood yields a tannin also, with some distinctive peculiarities. That got from sumac by drying and grinding the shoots of the plant to a powder, yields a white sediment when precipitated by gelatine. A sixth kind is got from the wood of the *morus tinctoria* by maceration in water or alcohol. It is precipitated by a solution of common salt. A seventh is got from the *kino* of the shops, which is an extract from the *cocoloba urifera*. Its solution throws down gelatine of a rose colour, and forms with salts of iron a deep green precipitate. Tannin is now reckoned an acid, and other acids are procured from the various substances just mentioned.

Tannin exists in a great many vegetables, and chiefly in the barks of various trees. The following table by Sir H. Davy, exhibits the relative value of different kinds of barks. It gives the average obtained from 480 lb. of the entire bark of a middle sized tree, of the several species taken in spring when the quantity of tannin is largest:

	lb.
Oak	29
Spanish chestnut	21
Leicester willow, (large)	33
Elm	13
Common willow, (large)	11
Ash	16
Beech	10
Horse-chestnut	9
Sycamore	11
Lombardy poplar	15
Birch	8
Hazel	14
Black thorn	16
Coppuci oak	32
Inner rind of oak bark	72
Oak cut in autumn	21

The use of tannin in the arts is its property of combining with the gelatine of the skins of animals, and thereby rendering the leather prepared in this way thick and impervious to water.

The bark of the oak tree, which contains tannin in great abundance, is that which is most generally used by the tanner. The hides to be tanned are prepared for the process by steeping them in lime water, and scraping off the hair and cuticle. They are then soaked first in weaker infusions, and afterwards in stronger infusions of the bark, till at last they are completely impregnated. This process requires a period of from ten to eighteen months, if the hides are thick; and four or five pounds of bark are necessary on an average to form one pound of leather. Some recent improvements have shortened the process of steeping the hides. Bark is used in medicine, in the various forms, in which it is found, as a tonic.

Bitter and alkaline principles of vegetables. Many vegetables have an extremely bitter taste, such as quassia, peruvian bark, gentian, &c. This bitter principle has been ascertained, by the researches of modern chemists, to be of an alkaline nature. There are twenty-one of these alkaline substances now ascertained. They are all compounds of the following elementary substances: carbon, hydrogen, azote, and oxygen.

Quinine. This is one of the most important of the vegetable alkaline bitters. It was first discovered by Vauquelin in 1811, and its preparation on a large scale pointed out by Pelletier and Caventon, in 1820. It is obtained by boiling the yellow bark, (*cinchona cordifolia*) in water and sulphuric acid, and then treating it with lime and alcohol, when the quinina is precipitated in the form of a white powder. It is a pure bitter, possessing all the medicinal virtues of the Peruvian bark. The annual produce of this substance in Paris exceeds 120,000 ounces.

Strychnina exists in the seeds or fruits of several species of *strychnos*, as the *nux vomica*. Its taste is intensely bitter, it leaves an impression in the mouth similar to that produced by certain metallic salts, and it acts with great energy on the animal economy as a virulent poison.

Narcotic principle. This well known medi-

cinal property of certain vegetables, has also been ascertained to possess an alkaline quality. This narcotic principle is obtained from the milky and proper juices of some vegetables, and from the infusion of the leaves or stem of others. It exists in great quantity in the concrete juice of the poppy, and is known as opium. It is soluble in boiling water and alcohol, as well as in all acids. When distilled it emits white vapours, which are condensed into a yellow oil. Some water and carbonate of ammonia pass into the receiver, and at last carbonic acid gas, ammonia, and carburetted hydrogen are disengaged, and a bulky charcoal is left behind. Many other substances besides opium possess narcotic qualities. Thus the inspissated juice of the garden lettuce resembles opium in its appearance and qualities, and is obtained in a similar manner. The deadly night shade furnishes a narcotic substance, as do also hemlock, black hellebore, strammonium, and fox-glove. All these are active poisons, if taken in large quantity.

Vegetable acids. The acids derived from the vegetable kingdom have been multiplied by modern chemists to the number of 116. Some of these acids exist ready formed in the juices of the plant, as the acetic, oxalic, citric, malic, &c.; others are in certain states of combination, and do not exhibit their acid qualities until artificially decomposed, such as the camphoric, suberic, pyrolignous, &c.

Oxalic acid. If the expressed juice of the wood sorrel, (*oxalis acetocella*) is left to evaporate slowly, it deposits small crystals of a yellowish colour and saltish taste, which are known by the name of salt of sorrel, that is, a salt with excess of acid; from which the acid may be obtained pure, by a simple chemical process. Oxalic acid, in its pure state, is always solid. Its taste is sharp and acrid. It is readily soluble in cold water, and is distinguished from other acids by its property of decomposing all calcareous salts, and forming with lime a salt insoluble in water. Hence it is used by chemists as a test to detect the presence of calcareous salts. But it is not used in medicine or the arts, except in its state of acidulum, in which it is employed to make a sort of lemonade, and to discharge stains of ink. It has been found also in *oxalis corniculata*, *geranium aciduum*, in the several species of *rumex*, and in the pubescence of *cicer arietinum.*

Acetic acid, or vinegar, which is generally manufactured from wine or sugar in a certain stage of fermentation, has also been found ready formed in the sap of several trees, as analysed by Vauquelin; and also in the acid juice of the *cicer arietinum*, of which it forms a constituent part. It was obtained also by Scheele from the sap of the *sambucus nigra*, and is consequently to be regarded as a native vegetable acid. It is distinguished from other vegetable acids by its forming soluble salts with the alkalies and earths.

Citric acid. This substance exists in the juice of the lemon. It has an agreeable acidulous taste, especially when diluted with water. By a red heat it yields carbonic acid gas, and carburetted hydrogen gas, and is reduced to charcoal. Nitric acid converts it into oxalic and acetic acid; and with lime it forms a salt insoluble in water. It is much used as lemon juice to give a seasoning to liquors, which it does equally well in its concentrated state also. It has been found in an unmixed state in the following vegetable substances: in the juice of oranges and lemons, and in the berries of *vaccinium oxycoccus*, *vitis idæa*, *prunus padus*, *solanum dulcamara*, and *rosa canina*, as well as in many fruits mixed with other acids.

Malic acid. This acid is found in the juice of unripe apples, whence it derives its name; but it is found also in the juice of berberries, elderberries, gooseberries, plums and common house leek. It cannot be obtained in a crystallized and solid form; but if left exposed to the air, it becomes thick and viscous. It is decomposed by heat and strong acids; nitric acid converts it into oxalic acid. It combines with the alkalies and several of the metals, and forms with lime a soluble salt, by which test it is distinguished from other acids. It is used chiefly in the laboratory.

Gallic acid. This acid is derived chiefly from nut galls, by exposing a quantity of the powder to a moderate heat in a glass retort, where the acid will form on the top in octohedral crystals. Its taste is austere and astringent; and it reddens vegetable blues. It is soluble both in water and alcohol, and communicates to solutions of iron a deep purple or black colour. When exposed to a gentle heat, it sublimes without alteration; but a strong heat decomposes it. Nitric acid converts it into the malic and oxalic acids. It is of great utility in the art of dyeing, and forms the basis of all black colours, and of those with a dark ground. It is an excellent test of the presence of iron, and with the sulphate of iron or copperas it forms common writing ink.

Tartaric acid. In old wine which has been kept in a cask, a sediment is precipitated which adheres to the sides and bottom, and forms a crust known by the name of tartar, which is a combination of potass and a peculiar acid in excess. The compound is supertartrate of potass and the acid in its state of purity is the tartaric acid with potass; it forms a salt that is with difficulty soluble. It exists in the following vegetable substances: in the pulp of tamarinds, in the juice of the grape, mulberries, sorrel, and sumac; and the roots of *triticum repens*, and *leontodon taraxacum.* It is not much used except by chemists; but the supertartrate, from which

it is usually obtained, is well known as the useful medicine called cream of tartar.

Benzoic acid. The benzoin of the shops is a resinous exudation from *styrax bensoe*, a tree which grows in the island of Sumatra. From this substance benzoic acid is procured. As it is met with in commerce, it is usually contaminated with some resinous and oily matters. When pure, benzoic acid has no smell; when sublimed, it assumes the form of long flat prismatic needles, having a beautiful silvery lustre. It is used in medicine more to give flavour to other more active drugs than for any efficacy it possesses of itself.

Prussic acid. This acid is generally classed among the animal acids, because it is obtained in greatest abundance from animal substances. But it has been proved to exist in vegetable substances also, and is procured by distilling laurel leaves, or the kernels of the peach and cherry, or bitter almonds. When pure it forms a colourless fluid, with an odour resembling that of the peach blossom. It does not redden vegetable blues, but it is characterised by its property of forming a bluish-green precipitate when it is poured with a little alkali added to it into solutions containing iron. It is a virulent poison. From experiments on the vegetable acids, it appears that they all contain, as elements, carbon, oxygen, and hydrogen, and that prussic acid contains a portion of nitrogen. Gallic acid contains more carbon than the other vegetable acids, and oxalic acid more oxygen.

Modern chemistry has detected a great many more acids in vegetable substances, such as in kino, cinnamon, camphor, &c.

Oils. Vegetable bodies afford a great variety of oily substances, differing considerably in their properties. These oils have been divided into fixed, solid, and volatile. Fixed oils are but seldom found except in the seeds of plants, and especially in the dicotyledonous class. Occasionally they exist in the pulp of fleshy fruits, as in that of the olive, which yields the most abundant and valuable species of all fixed oils. But dicotyledonous seeds which contain oil, contain also at the same time a quantity of mucilage and fecula, and form, when bruised in water, a mild and milky fluid known by the name of emulsion; on this account they are sometimes denominated emulsive seeds. Some seeds readily yield their oil by simple pressure, having been previously reduced to a soft pulp by pounding them in a mortar. Others require to be exposed to the action of heat, which is applied to them by means of pressure between warm plates of tin, or of the vapour of boiling water, or of roasting before they are subjected to the press. But the oil which is thus expressed, is still mixed or combined with other substances, such as fecula, starch, and mucilage, which sometimes subside spontaneously, if the liquid is kept in a state of repose; first the grosser parts, such as the fragments of parenchyma, that may have been expressed along with the oil; then the green fecula, then the starch, and lastly the mucilage. The oil is now left in a state of tolerable purity, but not yet without a mixture of other substances, to deprive it of which chemists employ a variety of processes. Fixed oil, when pure, is generally a thick and viscous fluid, of a mild or insipid taste, and without smell. But it is never entirely without some colour, which is for the most part green or yellow. Its specific gravity is to water as 9.403 to 1.000. It is insoluble in water, is decomposed by the acids, and with the alkalies it forms soap. When exposed to the atmosphere it becomes inspissated and opaque, and assumes a white colour and a resemblance to fat. This is in consequence of the absorption of oxygen; but owing to the appearance of a quantity of water in oil that is exposed to the action of the air, it has been thought that the oxygen absorbed by it is not yet perhaps assimilated to its substance. When exposed to cold it congeals and crystallizes, or assumes a solid and granular form; but not till the thermometer has indicated a degree considerably below the freezing point. When exposed to the action of heat it is not volatilized till it begins to boil, which is at 600° of Fahrenheit. By distillation it is converted into water, carbonic acid, and carburetted hydrogen and carbon; the product of its combustion is nearly the same, and hence it is a compound of carbon, oxygen, and hydrogen. Some oils remain solid at the ordinary temperature of the atmosphere, such as palm and cocoa-nut oil, and wax, which in its properties resembles the oleaginous bodies. Of the fixed oils some are of a fatty nature, and are readily inspissated by the action of the air; others dry into a sort of tenacious varnish.

Olive oil is expressed from the pulp of the fruit of the olive tree, (*Olea Europea*) a shrub that is indigenous to the south of Europe. In the manufacture of the oil, the fruit is first broken in a mill and reduced to a sort of paste. It is then subjected to the action of a press, and the oil, which is now easily separated, swims on the top of the water in the vessel beneath. It is manufactured chiefly in France and Italy, and is much used throughout Europe to give a seasoning to food.

Almond oil is extracted from the fruit of the almond tree, (*amygdalus communis*) a native of the south of Europe. The almonds are first well rubbed or shaken in a coarse bag or sack, to separate a bitter powder which covers their epidermis. They are then pounded to a paste in mortars of marble, which paste is afterwards subjected to the action of a press, and the oil is now obtained as in the case of the olive. It is

of a clear transparent colour, almost without smell or taste, and is used where fine oils are requisite.

Rapeseed oil is extracted from the *brassica, napus*, and *campestris*. It is less fixed, and less liable to become rancid than the two former, and is manufactured chiefly in Flanders.

Oil of behen is extracted from the fruit of the *guilandina mohringa*, common in Egypt and Africa. It is apt to become rancid, but is without odour, and is on this account much used in perfumery.

Drying oils. The principal of these are lintseed oil, nut oil, poppy oil, and hempseed oil. Lintseed is obtained from flax seed, which is first of all roasted, in order to dry up the mucilage contained in the seed, as also to promote the freer and more copious separation of the oil. This oil still contains a portion of mucilage, and hence perhaps its property of quickly drying and hardening depends. Long boiling converts it into a sort of varnish. With the oxide of lead it forms a convenient lute, much used in the arts. Nut oil is extracted from the hazel or walnut. The kernel is first slightly roasted, and then subjected to pressure, when the oil flows out. It is used for food in some parts of France, and in the coarser kinds of painting. It is apt to become rancid. Poppy oil is procured from the seeds of a poppy, (*papaver somniferum*) which is cultivated in France for this purpose. It is clear and transparent, and dries readily; and when pure is without taste and odour. It is used for the same purposes as the olive oil, for which it is often sold. Hempseed oil is procured from the hemp, has a harsh and disagreeable taste, and is used only for mixing up the coarser paints.

Volatile oils. A great variety of vegetables contain an oil which, being of a lighter and less permanent nature than the fixed oils, has been called volatile or essential oil. These oils pervade almost every part of the plant. They are found in many roots, to which they impart a fragrant and aromatic odour, with a somewhat acrid taste. The roots of *inula helenium, genista canariensis*, and many others, contain oils of this sort. They are found also in the bark, as in the cinnamon tree; or in the wood, as in the sassafras and the fir; in the leaves of labiate plants, such as mint, rosemary, marjoram; and of the odorous *umbelliferæ*, such as fennel, charvil, angelica; and of plants with compound flowers, such as worm-wood. They are found also in the flower itself, as in the flowers of camomile and the rose; and in the fruit, as in pepper and ginger; and lastly, in the external integuments of many seeds; but never in the cotyledon. It is probable that every plant possessing a peculiar odour owes this to a peculiar oil, and that this aroma is caused by the volatile particles of the oil being continually given off from the plant. Volatile oils are obtained by expression from the plant, or distillation. They are characterised by their strong and aromatic odour, and rather acrid taste. They are soluble in alcohol, but are not readily converted into soaps by alkalies. They are very inflammable, and are volatilized by a gentle heat. Like fixed oils, their specific gravity is generally less than that of water, on the surface of which they will float, though in some cases it is found to be greater than that of water, in which they consequently sink. They are much prized, on account of their agreeable taste and odour, and are prepared and sold under the name of distilled waters or essences. Oil of turpentine is used as a varnish, and for mixing with other oils in the composition of pigments.

Wax. This substance is found exuding from the upper surface of the leaves of many trees. It exudes also from other parts of the plants besides the leaf, and assumes a more stiff and concrete form, as from the catkins of the poplar, the alder, and the fir, from the fruit of the *myrica cerifera* and *croton sebiferum;* but particularly from the antheræ of flowers. Bees' wax, though an animal production, agrees so closely in all its characters with that from plants, that there can be no doubt of their being the same substance. It was at one time the opinion of naturalists, that the bees collected their wax ready formed from the pollen of plants; but Huber has shown that the pollen which the bees carry to their hives is employed as the food of their larvæ; and that the wax is manufactured by them from the saccharine juices of the flower. It exudes from the rings in the abdomen of these insects, and is employed by them in constructing the walls of their cells. Wax, as it comes from the bee-hive, has a yellow colour and a peculiar smell, both of which are derived from the honey with which the wax cells are filled. To free it from these impurities, it is melted in water and cast into thin ribbons, which are exposed to the light of the sun, till, by the joint action of the light and moisture, they are bleached white. Several fusions and exposures are required, however, to render it perfectly pure.

Wax, when pure, is tasteless and inodorous, insoluble in water or alcohol, but combines with the fixed oils, forming with them a paste or cerate. It readily combines with alkalies, and assumes the consistence of soap. The acids have little action on it, and on this account wax forms a convenient chemical lute. Wax softens with heat, and melts at the temperature of 142° if unbleached, and 155° when pure; at a higher temperature it boils and passes off into vapour, which vapour may be set on fire by the application of a red heat. Hence, its utility in mak-

ing candles; and hence an explication of this singular phenomenon observable in the *pictamnus fraxinella*. This plant is fragrant, and the odour which it diffuses around forms a partial and temporary atmosphere, which is inflammable; for if a lighted candle or other ignited body is brought near to the plant, especially in the time of droughts, its atmosphere immediately takes fire. This phenomenon was first observed by the daughter of the celebrated Linnæus, and is explained by supposing the partial and temporary atmosphere to contain a portion of wax exuded from the plants, and afterwards reduced to vapour by the action of the sun. The result of its combustion in oxygen gas was, according to Lavoisier, carbonic acid and water, in such proportions as to lead him to conclude that 100 parts of wax are composed of 82.28 of carbon, and 17.72 of hydrogen. But owing to the little action of acids on it, there seems reason to believe that it contains also oxygen as an ingredient. Wax possesses all the essential properties of a fixed oil. But fixed oils have the property of becoming concrete, and of assuming a waxy appearance when long exposed to the air, in consequence, as it seems, of the absorption of oxygen. Wax, therefore, may be considered as a fixed oil rendered concrete, perhaps by the absorption of oxygen during the progress of vegetation. But if this theory is just, the wax may be expected to occur in a considerable variety of states, according to its degree of oxygenation, and this is accordingly the case. Sometimes it has the consistency of butter, and is denominated butter of wax, as butter of coco, butter of galam; sometimes its consistency is greater, and then it is denominated tallow, as tallow of croton; and when it has assumed its last degree of consistency, it then takes the appellation of wax. The butter of cacao is extracted from the seeds of the *theobroma cacao*, or chocolate plants, either by boiling them in water, or by subjecting them to the action of the press, after having exposed them to the vapour of boiling water. They yield almost half their quantity of butter. It is at first brown or yellow, but when well purified it is white; its taste is sweet, its fracture slightly granular, and its touch unctuous. It is to this butter that chocolate owes its flavour and unctuosity. Butter of coco is found in the fruit of the coco-nut tree. It is expressed from the pulp of the nut, and is even said to separate from it when in a fluid state, as cream separates from milk. Butter of nutmeg is obtained from the seeds of the *myristica officinalis*, or nutmeg tree. They are pounded and formed into a paste with water, and then subjected to the action of the press. The butter is firm and orange coloured, and of a sweet and aromatic smell. From the *croton sebiferum*, a tree that grows in Asia and America, a waxy substance is extracted, of the consistence of tallow. It adheres to the surface of the fruit, and is detached from it by means of boiling the fruit in water. Its odour is rather pleasant, but it acts as a violent purgative. The Chinese use it in the manufacture of candles.

The *myrica cerifera*, a plant which grows abundantly in Louisiana and other parts of North America, furnishes the wax of myrtle. The berries, which are about the size of a pepper corn, are gathered and thrown into a kettle which is nearly filled with water. The water is then made to boil, and the wax which is extracted floats on the surface. It is of a pale green colour; its specific gravity is 1.0150, it melts at the temperature of 109°; and when strongly heated burns with a white flame producing smoke, and emitting an agreeable odour. Wax is also extracted from a variety of other vegetables, and has been detected by Proust in the green fecula of many plants, as in that of the cabbage. He considers it as a constituent part of the pollen of all flowers, and thinks that the bees collect it along with the gluten of the pollen, which, according to him, serves them for food. Certainly it is one of the most abundant of vegetable principles, and is of great utility both in medicine and in the arts. Its soft and unctuous qualities render it fit for being employed as an ingredient in ointments and plasters, and in a great variety of other medicaments. It is employed also by the sculptor, statuary, and modeller, in the exercise of their arts. But its chief utility consists in its being better adapted than all other substances for the manufacture of candles. The candle burns with a clear and brilliant flame, and the wick needs no snuffing.

Resins. The term *resina* was given by the ancients to the expressed juice of certain pine trees, and corresponds to our common resin. Many vegetables yield a resinous juice. It is obtained either by exudation from trees, or by digesting the substance containing the resin in alcohol. In the first case, it exudes from natural or artificial openings in the bark and part of the wood of trees. The resin flows out in summer in a liquid state, it being held in solution by a volatile oil, which, when the exudation is exposed to the air, either makes its escape or is converted into resin by the absorption of oxygen. When this change takes place the liquid is converted into a solid resin. In the second place, the alcoholic solution being diluted with water, the resin falls down, and the alcohol is recovered by distilling the diluted liquor.

Resins are solid substances, naturally brittle, have a certain degree of transparency, and a colour most commonly inclining to yellow. Their taste is insipid, and they have no smell except when they retain a portion of volatile oil, in which case they partake of the odour and acrid taste of that oil. They are insoluble in

water, most of them are souble in alcohol, and some of them in the fixed oils. When exposed to heat they melt and afterwards take fire, burning with a strong yellow flame, and evolving a great deal of smoke. Their elementary constitution consists of carbon, hydrogen, and oxygen.

Resin, or *Rosin*. This substance exudes in the form of drops or tears, from the various species of pines. Its flow is generally aided by means of incisions into the bark and wood, and it receives different appellations according to the species from which it is obtained. If it is obtained from the *pinus sylvestris*, it is denominated common turpentine; from *pinus larix* Venice turpentine; or from *amyris balsamea*, Canada balsam. It originally consists of two ingredients, oil of turpentine and rosin. The oil is extracted by distillation, and the resin remains behind. If the distillation is continued to dryness, the residuum is common rosin, or colophonium; but if water is mixed with it while yet fluid and incorporated by violent agitation, the residuum is yellow rosin. The yellow rosin is the most ductile, and the most generally used in the arts. Oil of turpentine begins to boil at 313° of the thermometer; but if the ebullition be still farther continued, the temperature rises to 350°, or even higher, showing the presence of more than one volatile oil.

From the resinous juices of the fir, the substances known by the name of pitch and tar are also manufactured. The trunk is cut or cleft into pieces of a convenient size, which are piled together in heaps, and covered with turf. They are then set on fire, and the resinous juice which is thus extricated, being prevented from escaping in a volatile state by means of the turf, is precipitated and collected in a vessel beneath. It is partly converted into an empyreumatic oil, and is now tar, which by being farther inspissated, is turned into pitch.

Mastic. This resin is extracted from the *pistacea lentiscus*, a tree which grows plentifully in the island of Chios. It exudes in a fluid state from incisions made in the stem, and concretes into brittle grains, somewhat yellowish and semi-transparent, In this state it is sold under the name of mastic. It has scarcely any taste; but when heated it melts and exhales a fragrant odour. It is sometimes employed as a varnish.

Sandarac. This resin is obtained from the *juniperus communis*, or common juniper, by spontaneous exudations. It concretes in the form of small round tears, somewhat brownish and semi-transparent, resembling mastic. It is also employed as a varnish.

Elemi. This resin is extracted from the *amyris elemifera*, a tree which grows in North America. It exudes from incisions made in the bark during dry weather, and is left to harden in the sun. It is of a pale yellow colour, and strong smell, and is somewhat semi-transparent.

Tacambac. This resin is the produce of the *fagara octandra*, and *populus balsamifera*. It is brought from America in large oblong masses, wrapped in flag leaves. Its colour is light brown. It is brittle but easily melted by heat, and it has been found to be soluble in alkalies and nitric acids.

Labdanum. This resin is obtained from the *cistus creticus*, a shrub which grows in Candia and other Grecian islands. The surface of the leaves is covered with a viscid juice, which is collected by a sort of rake furnished with thongs of leather, to which the juice adheres. It is afterwards scraped from the thongs with a knife. It is very soft, and always mixed with sand and dust. Its colour is blackish, its odour fragrant, and its taste bitter. When dissolved in alcohol, it leaves behind it a little gum. It is employed in medicine as an astringent.

Opobalsamum, or *balm of Gilead*. This resin, which has obtained a sort of notoriety for its fancied medical virtues, is the produce of the *amyris Gileadensis*, a shrub which grows in Judea and Arabia; but it is so much valued by the Turks, that its importation is prohibited. This is the balm of Gilead so much celebrated in Scripture. Pliny says it was first brought to Rome by the generals of Vespasian. It is obtained in a liquid state from incisions in the bark, and is somewhat bitter to the taste.

Copaiva balsam. This resin is obtained from the *copaifera officinalis*, a tree which grows in South America. It exudes from artificial incisions, having at first the consistence of oil, but gradually assuming the consistence of honey. It is transparent, and of a yellow colour, with an agreeable smell, but pungent nauseous taste. It is a combination of resin and volatile oil, which may be separated by distillation with water. It is insoluble in water, but abundantly soluble in alcohol. It is used only as a medicine.

Dragon's blood. This resin is obtained from the *dracœna draco*, *pterocarpus draco*, and *calamus rotang*, plants that grow in the East Indies, and in Spanish America. Its colour is a dark red. It is tasteless and almost inodorous. Its fracture is glossy, and its powder of a deep crimson hue. It is brought to this country in small masses, wrapped in leaves, and is used chiefly as a tooth powder.

Guiac. This resin is the produce of the *guiacum officinale*, a tree which grows in the West Indies. It exudes spontaneously, or is driven out in a melted state by means of the action of heat. Its colour is green with some transparency, its consistence brittle, its fracture vitreous. It has scarcely any taste, and no smell; but when thrown on burning coals it exhales a fragrant odour. It is used in medicine.

Botany Bay resin. This resin is said to be the produce of the *acarois resinifera*, a tree which grows abundantly in New Holland, especially near Botany Bay. The resin exudes spontaneously from the trunk of the singular tree which yields it, especially if the bark be wounded. It is at first fluid, but becomes gradually solid when dried in the sun. It is insoluble in water, but communicates to that liquid the flavour of storax. Alcohol dissolves it.

Green resin. This resin constitutes the colouring matter of the leaves of trees, and of almost all vegetables. It is insoluble in water, but soluble in alcohol. When treated with oxymuriatic acid it assumes the colour of a withered leaf, and exhibits the resinous properties more distinctly.

Copal. This resin is obtained from the *rhus copallinium*, a tree which is found in North America. It is a transparent substance, with a slight tinge of brown. It possesses the general properties of other resins, but differs from them in not being soluble in alcohol or oil of turpentine, without peculiar management. When dissolved in any volatile liquid, and spread thin upon wood, metal, or paper, so that the volatile menstruum may evaporate, it forms one of the most perfect and most beautiful of all the varnishes, known by the name of Copal varnish. For this purpose it is generally dissolved in oil of turpentine.

Anime. This resin is obtained from the *hymenæa courbaril*, or locust tree, a native of North America. It resembles copal exactly in its appearance, but differs from it in being readily soluble in alcohol. It is employed also in making varnishes.

Lac. This resin is the produce of the *croton lacciferum*, a native of the East Indies. It exudes in consequence of the puncture of an insect, whence it is supposed to derive its colour, which is deep red verging to brown, with a degree of semi-transparency. It forms the basis of many varnishes, and of the finest kinds of sealing wax.

Bloom. Upon the epidermis of the leaves and fruits of certain species of plants, there is to be found a fine soft and glaucous powder. It is particularly observable upon cabbage leaves, and upon plums, to which it communicates a particular shade. It is known to gardeners by the name of bloom. It is easily rubbed off by the fingers, and when viewed under the microscope seems to be composed of small opaque and unpolished granules, somewhat similar to the powder of starch; but with a high magnifying power it appears transparent. When rubbed off it is again reproduced, though slowly. It resists the action of dews and rains, and is consequently insoluble in water. But it is soluble in alcohol. from which circumstance it has been suspected with some probability to be a resin.

Such are some of the most remarkable of the resins that have been subjected to chemical analysis, or employed in medicine or the arts. Their medical virtues, however, are not quite so great as has been generally supposed, but their utility in the arts is very considerable. They are employed in the arts of painting, varnishing, embalming, and perfumery; and they furnish us with two of the most important of all materials to a naval power, pitch and tar.

Gum resins. There are many plants which, when cut or pierced, give out a milky juice more or less thick. This juice has generally a strong taste, and frequently also a peculiar smell. These milky juices are contained in the living plant in a peculiar set of vessels, which usually run along the interior part of the bark. The common *leontodon taraxicum*, *lactuca virosa*, the different species of *euphorbia*, and the poppy, may be mentioned as examples of plants yielding these milky juices. When the milky juice is made to exude from a plant, and then exposed to the atmosphere, it becomes solid, and assumes different appearances according to the plant from which it is obtained. Now these concrete juices are the substances which have long been distinguished by the name of *gum resins*. Gum resins are usually opaque, or at least their transparency is inferior to that of resins. They are always solid, and most commonly brittle, and have sometimes a fatty appearance. When heated they do not melt as the resins do, neither are they so combustible. Heat, however, commonly softens them, and causes them to swell. They burn with a flame. They have almost always a strong smell, which, in several instances, is similar to that of garlic. Their taste also is often acrid, and much stronger than that of the resins. They are partially soluble in water, but the solution is always opaque, and usually milky. Alcohol dissolves only a portion of them, the solution is transparent; but when diluted with water it becomes milky. They dissolve much better in dilute alcohol.

Galbanum. This substance is obtained from the *bubon galbanum*, a perennial plant found at the Cape of Good Hope. An incision is made in the stem a little above the root, and the milky juice flows out. When it concretes it constitutes galbanum. It is brought into this country in small pieces, composed of agglutinated tears of a yellow colour, acrid and bitter taste, and smell of garlic. Water, vinegar, and wine, dissolves the greater part of it, but the solution is milky. It is chiefly used in medicine.

Ammoniac. This substance is brought from Africa in the form of small tears, but nothing certain is known concerning the plant which yields it. It is thought to be a species of *ferula*.

Its colour is yellow, and taste nauseous. It is used sometimes in medicine.

Scammony. This substance is the produce of the *convolvulus scammonia*, a climbing plant which grows in Persia. The root when cut yields a milky juice by expression, which, when it concretes, forms scammony. Its colour is dark gray, its smell nauseous when rubbed, and its taste bitter. It forms with water a green opaque liquid. It is much employed in medicine, and operates as a strong purgative.

Opoponax. The plant from which this substance is obtained, is the *pastinacea opoponax*, a native of the countries of the Levant. It exudes in the state of a milky juice, from incisions made in the root. It is afterwards dried in the sun, and is generally to be met with in lumps of a reddish colour, and white within. Its taste is bitter and acrid, and it forms with water a milky solution.

Euphorbium. This substance is the produce of the *euphorbia officinalis*, a plant which grows in Africa. It is the milky juice of the plant dried in the sun, and obtained by means of incisions. It assumes the form of small yellow tears. It has no smell, its taste is caustic. It is poisonous, but is occasionally employed in medicine.

Olibanum. This substance is obtained from the *juniperus lycia*, which grows in Arabia, particularly by the borders of the Red sea. It is the frankincense of the ancients. It exudes from incisions made in the tree, and concretes into masses about the size of a chestnut. It is brittle, transparent, and of a yellow colour. It has little taste, but when burnt diffuses an agreeable odour.

Sagapenum. The plant from which this substance is obtained is not well known; but it is supposed to be the *ferula Persica*. The substance itself is brought from Egypt, Persia, or India. It is generally in the form of agglutinated tears. Its colour is yellow, its taste hot and bitter, and its smell alliaceous.

Gamboge is the produce of the *mangostana cambogia*, a tree which grows in the East Indies. It exudes from incisions of the bark, and is brought to Europe in large cakes or cylindrical masses. Its colour is yellow, and its fracture vitrious; but it has no smell and very little taste. It forms with water a yellow turbid liquid, but is soluble almost entirely in alcohol. In medicine it is a strong purgative. It is much used as a pigment.

Myrrh. This substance is procured from a tree which grows in Abyssinia and Arabia; the real species of which has not yet been ascertained. According to Bruce it belongs to the *mimosa.* It exudes from the tree in the state of a yellowish white liquid, which soon concretes into a solid substance. The best is transparent, and has a reddish brown colour. Its odour is strong and peculiar, its taste bitter and aromatic. It does not melt when heated, and burns with difficulty. It is occasionally used in medicine, and as a dentifrice.

Asafœtida. This substance, so well characterised by its strong and fœtid smell, is obtained from the ferula asafœtida, a plant which grows in Persia. At four years old the plant is dug up by the root; the root is then cleaned and the extremity cut off; a milky juice exudes, which is collected; and when it ceases to flow another portion is cut off and more juice extricated. The process is continued till the root is exhausted. The juice which has been collected soon concretes, and constitutes asafœtida. It is brought to Europe in small agglutinated grains of different colours: white, red, and yellow. It is hard but brittle. Its taste is bitter, and its smell insufferably fœtid; and yet the Indians use it as a seasoning for their food, and call it the food of the gods. This forms a strong contrast to the name it has obtained in Europe, where it is vulgarly known by the appellation of devil's dung. It is used in medicine.

Aloes. Strictly speaking, aloes hardly belongs to the gum resins; but as it often exudes spontaneously from the leaves when the point of these is cut off, and afterwards gradually concretes into a solid mass, the analogy is so close as to warrant its insertion here.

Two kinds of aloes occur in commerce, *Socotara aloes*, and *Barbadoes aloes.* The first kind came originally from Socotora, an island at the entrance of the Red sea; but of late years this country is almost entirely supplied with aloes from Bombay. The plant which yields this variety is the *aloe spicata.* The leaves are cut off close to the stem, then cut in pieces, and their juice allowed to run out; after a sediment has subsided the clear liquid is allowed to concrete in the sun. The taste of aloes is entirely bitter; it is soluble in alcohol and water, and is much used in medicine as a purgative.

Balsams. The substances known by the name of balsams are nearly related to the resins and gum resins. They all contain benzoic acid. They are obtained by incisions made in the bark, from which a viscous juice flows, which is afterwards thickened by exposure to the sun or a fire; or they are obtained by boiling the part of the tree containing them. They are thick and viscid juices, but become readily concrete; their colour is brown or red; their smell aromatic when rubbed; their taste acrid. They are insoluble in water, but boiling water extracts part of their acid; they are soluble in the alkalies and nitric acid. When heated they melt and swell, evolving a white and odorous smoke.

Benzoin. It was long supposed that this substance was the produce of a species of *laurus;*

but it appears from the observations of Mr Dryandi, to be the produce of a species of *styrax*, a tree which grows in Sumatra, and is known as the *styrax benzoin*. It flows from incisions made in the trunk, and comes into Europe in masses of a light brown colour, variegated with yellow specks. It is brittle, with a vitrious fracture. It is soluble in alcohol; when rubbed it emits a fragrant odour; and when heated the benzoic acid is sublimed in the form of white crystals. It is used in medicine and perfumery.

Storax. This balsam is obtained from the *styrax officinale*, a tree which grows in France, Italy, and the islands of the Levant. It is extracted by means of incisions, and concretes into cakes or masses of an irregular form, and a brown or reddish colour. Its taste is spicy, and its smell fragrant: it is employed in perfumery.

Styrax. This substance is a semi-fluid juice. The tree from which it flows is cultivated in Arabia; but the true species has not yet been ascertained. It is known to the natives by the name of *rosamallos*. The balsam procured from it is greenish, its taste aromatic, and its smell pleasant. It is a combination of benzoic acid, and resin, and is used in medicine occasionally.

Balsam of Tolu. This substance is the product of a tree of South America, the *toluifera balsamum*. It flows from incisions made in the bark, and is brought to Europe in small gourd shells. Its colour is brown, and its smell very fragrant. It is employed in medicine, and was at one time thought efficacious in diseases of the lungs.

Balsam of Peru. This balsam is obtained from the *myroxylor Peruiferum*, a tree which is found in South America. It is extracted by boiling the twigs in water; after evaporation the extract is put into cocoa nut shells, and in this state brought to Europe. It resembles the balsam of tolu in its chemical properties, as far as they have been hitherto examined, and is applied to the same medical purposes; but its consistency is less solid, and it is more easily volatilized by heat.

Camphor. This substance was unknown to the Greeks and Romans, but appears to have been first brought into notice by the Arabian physicians. Sotius is the first person who notices it under the name of *kamphur*. A great variety of plants, especially the *labiatæ*, contain camphor, such as thyme, rosemary, lavender, zedoary, sassafras; but it is chiefly obtained from the *laurus camphora*, a tree which grows in Japan and the islands of the East Indies. In order to obtain it, the root and stem of the plant are cut into small pieces, and put into a large alembic furnished with a head, and containing some water. When sufficient heat is applied, the camphor sublimes in the form of small grayish grains, which are afterwards worked into larger masses by friction. In this state it is impure, but it is afterwards refined by a second distillation. Camphor, when pure, is a white brittle substance, forming octagonal crystals, or square plates. Its taste is peculiarly hot and acrid, leaving afterwards a sensation of cold; its odour is strong and aromatic. When broken into small fragments and put into water, on the surface of which it swims, a singular phenomenon ensues. The water surrounding the fragments is immediately put into commotion, advancing and retiring in little waves, and attacking the fragments with violence. The minuter fragments are driven backwards and forwards upon the surface, as if impelled by contrary winds. If a drop of oil is let fall on the surface of the water, it produces an immediate calm. This phenomenon has been attributed to electricity. Fourcroy thinks it is merely the effect of the affinities of the camphor, water, and air, entering into combination.

Camphor is not altered by exposure to the air, but it is so volatile that it evaporates completely, if exposed to it in warm weather. It is insoluble in water, to which, however, it communicates its peculiar odour. It is readily soluble in alcohol; and in the acids its solution in nitric acid forms what is called oil of camphor. It melts at the temperature of 300°, and is so inflammable that it will burn even on the surface of the water. It burns with a bright flame, and leaves no residuum. If formed into a paste with water and alumina, and distilled in a glass retort, the products are volatile oil, camphoric acid, carbonic acid gas, and carburetted hydrogen gas, with a residuum of charcoal and alumina, in such proportions as to warrant the conclusion that the ultimate ingredients of camphor are carbon and hydrogen.

Camphor is much employed in medicine. It is regarded as a powerful stimulant and antispasmodic. It is particularly offensive to insects, and is frequently used as a preservative in cabinets of natural history.

Caoutchouc. This substance was introduced into Europe about the beginning of last century; and from its being applied to rub out the stains of black-lead pencils, it got the name of India rubber. It is obtained from at least two trees, natives of South America, the *jatropa elastica*, and *hævea caoutchouc*, and from the *ficus indica*, *artocarpus integrifolia*, and *urceola elastica* of the East Indies. If an incision is made into the bark of any of these plants, a milky juice exudes, which, when it is exposed to the air, concretes and forms *caoutchouc*. As the object of the natives in collecting it had been originally to form it into vessels for their own use, it is generally made to concrete in the form of bags or bottles. This is done by applying the juice, when fluid, in thin layers, to a mould of dried clay, and then

leaving it to concrete in the sun, or by the fire. A second layer is added to the first, and others in succession, till the vessel acquires the thickness that is wanted. The mould is then broken, and the vessel fit for use; and in this state it is generally brought to Europe. It is brought over in its milky state also, by being excluded from the action of the air. If the pulpy juice be exposed to the air, an elastic pellicle is formed on the surface. If it is confined in a vessel containing oxygen gas, the pellicle is formed sooner. If oxymuriatic acid is poured into the milky juice, the caoutchouc precipitates immediately. This renders it probable that the formation of the caoutchouc is owing to the absorption of oxygen.

When pure this substance is of a white colour, without taste or smell. The black colour which it commonly presents is owing to the method of drying the different layers upon the moulds on which they are spread. They are dried by being exposed to smoke. The black colour of the caoutchouc, therefore, is owing to the smoke or soot alternating with its different layers. It is soft and pliable like leather, and extremely elastic, so that it may be stretched to a very great length, and still recover its former size. Mr Gough of Manchester has made some curious experiments on the changes of temperature which this substance undergoes on its being stretched out suddenly, from which it would appear that ductility, or elasticity, as well as fluidity, depends upon latent heat. It is not altered by exposure to the air; is insoluble in water; but if boiled in this fluid for some time, its edges become so soft as to adhere if pressed together closely for some time. It is insoluble in alcohol; but soluble in pure ether and some of the volatile oils, as also the alkalies. Naptha, or the essential oil derived from tar or coal gas, is a ready solvent of this substance. It is also acted on by acids; and from their decomposition, it seems to consist of the elementary constituents of carbon, hydrogen, oxygen, and nitrogen.

Caoutchouc exists in many vegetables, combined with other ingredients. From resins it may be separated by their solution in alcohol; and from the berries of the misseltoe it may be separated by the addition of water. Opium and mastic contain a portion of it, but not a sufficient proportion to compensate the labour of its extraction. It is applied to many useful purposes. Rolled out into very thin plates it forms a tenacious covering to jars and phials, and is quite impervious to water and most liquids. It is also used to construct tubes and cylinders for chemical and surgical purposes; and dissolved in naptha, and spread over various kinds of cloth, it forms the Mackintosh fabrics, now so universally used. An immense quantity of this substance is now imported into this country for this manufacture, and consequently its price has been greatly raised. In the countries where it is produced the natives manufacture it into bottles, make of it boots and shoes, and often burn it instead of candles.

Cork. This well known and useful article is the outer bark of the *quercus suber*, or cork tree, a kind of oak that grows abundantly in France, Italy, and Spain. To prevent its natural exfoliation, which is always irregular, and to disengage it in convenient portions, a longitudinal incision is made in the bark from the root to the top of the stem, and a transverse and circular incision at each extremity; the outer layer, which is cork, is then stripped off, and to flatten and reduce it to sheets, it is put into water, and loaded with weights. The tree continues to thrive though it is thus stripped of its cork once in two or three years.

Cork is a light, soft, and elastic substance. Its colour is a sort of light tan. It is very inflammable, and burns with a bright white flame, leaving a black and bulky charcoal behind. When distilled it yields a small quantity of ammonia. Nitric acid corrodes and dissolves it, changing its colour to yellow, and finally decomposes it, converting it partly into an acid, and partly into a soft substance resembling wax or resin. The acid which is thus formed is denominated the *suberic acid*, and has been ascertained to be one of a peculiar nature. It seems probable that cork exists in the bark of some other trees as well as the *quercus suber*. There is a variety of the *ulmus campestris*, common in hedge rows, whose bark assumes something of the external appearance of cork, which it resembles in its thickness, softness, and elasticity, and in its loose and porous texture, as well as in its chemical properties. Fourcroy seems indeed to regard the epidermis of all trees to be a sort of cork, but does not say on what grounds his opinion is founded.

Woody fibre. The principal part of the stem, root, and branches of trees, is known under the denomination of wood; but this term is too general for the purpose of analytical distinction, as the part so designated often includes a great proportion of the substances that have already been described. It remains, therefore, to be considered whether there exists in the plant any individual substance different from those already described, and constituting more immediately the fabric of the wood. If a piece of wood is well dried and digested, first in water and then in alcohol, or such other solvent as shall produce no violent effects upon the insoluble parts, and if the digestion is continued till the liquid is no longer coloured, and dissolves no more of the substance of the plant, there remains behind a sort of vegetable skeleton, which constitutes the basis of the wood, and which has been called woody fibre. It is composed of bundles of lon-

gitudinal threads, which are divisible into others still smaller. It is somewhat transparent, is without taste or smell, and is not altered by exposure to the atmosphere. It is insoluble in water and alcohol; but the fixed alkalies decompose it with the assistance of heat. When heated in the open air it blackens without melting or frothing, and exhales a thick smoke and pungent odour, leaving a charcoal that retains the form of the original mass. When distilled in a retort, it yields an empyreumatic oil, carburetted hydrogen gas, carbonic acid, and a portion of ammonia. One hundred parts of the woody fibre of oak yielded, according to the analysis of Gay Lussac and Thenard,

Carbon,	52.53
Oxygen,	41.78
Hydrogen,	5.69

Charcoal. When wood is covered up from the full action of the atmosphere, and burnt with a smothered flame, the volatile parts are driven off by the heat, and there remains behind a substance exhibiting the exact form, and even the several layers, of the original mass. This process is denominated charring, and the product is charcoal. As it is the woody film alone which resists the action of heat, while the other parts of the plant are dissipated, it is plain that charcoal must be the residuum of woody fibre, and that the quantity of the one must depend upon the quantity of the other, if they are not rather to be considered as the same. Charcoal may be obtained from almost all parts of the plant, whether solid or fluid, and it is rendered perceptible by means of combustion. It often escapes, however, during this process, under the form of carbonic acid, of which it constitutes one of the elements. From a variety of experiments made on different plants, and on their different parts, it appears that the green parts contain a greater proportion of charcoal than the rest; but this proportion is found to diminish in autumn, when the green parts begin to be deprived of their glutinous and extractive juice. The wood contains more charcoal than the albumnum—the bark more than both; but this last result is not constant in all plants, because the bark is not a homogeneous substance, the outer parts being affected by the air, and the inner parts not. The wood of the *quercus suber*, separated from the alburnum, yielded, from a hundred parts of its dry substance, 19.75 of charcoal, the alburnum 17.5, the bark 26, leaves gathered in May, 80, in September, 26. But the quantity of charcoal differs also in different plants, as well as in different parts of the same. In the plants examined by Proust, the proportion was found to be as follows, the quantity of wood charred being represented by unity:—

Black Ash,	0.25
Guiacum,	0.24
Pine,	0.20
Green Oak,	0.20
Heart of Oak,	0.19
Wild Ash,	0.17
White Ash,	0.17

Charcoal is insoluble in water, of which, however, it absorbs a portion when newly made, as also of atmospheric air. It is incapable of putrefaction. It is not altered by the most violent heat that can be applied, if all air and moisture are excluded; but when heated to about 800°, it burns in atmospheric air or oxygen gas, and if pure, without having any residuum. It is regarded by chemists as being a triple compound, of which the ingredients are carbon, hydrogen, and oxygen.

Charcoal is of great utility, both to the chemist and artist, as a fuel for heating furnaces, as well as for a variety of other purposes. It is an excellent filter for purifying water. It is a very good tooth powder, and is an indispensable ingredient in the manufacture of gunpowder.

The Sap. If a branch of a vine is cut asunder early in the spring, before the leaves have begun to expand, a clear and colourless fluid will issue from the wound, which gardeners denominate the tears of the vine. It is merely, however, the ascending sap, and may be procured from almost any other plant by the same or similar means, and at the same season, but particularly from the maple, birch, and walnut tree, by boring a hole in the trunk. A small branch of a vine has been known to yield from twelve to sixteen ounces in the space of twenty-four hours. A maple tree of ordinary size yields about two hundred pints in a season, as has been already stated; and a birch tree has been known to yield in the bleeding season, a quantity equal to its own weight. The taste of this fluid is generally insipid, but sometimes it is slightly saline, and sometimes agreeably sweet, as in the case of the birch tree. If it is agitated but slightly a froth is formed on the surface; and if it is kept for any length of time in a close vessel, it ferments and effervesces spontaneously, and at length becomes strongly acid, assuming a bluish colour and a turbid appearance. At last it deposits a sediment, and resumes its transparency, but forms, at the same time, a thin and mouldy pellicle on the surface. If exposed to the action of heat it emits bubbles of carbonic acid gas, exhales a strong odour of vinegar, and yields, by distillation, carbonate of ammonia. Its charcoal contains carbonate of potass, carbonate of lime, and muriate and sulphate of potass. It combines, in all proportions, with water, which dilutes and dissolves it when thick and viscid. Strong acids deprive it of the carbonic and acetous acid which it contains, and occasion the

formation of carbonate of lime and acetate of potass, which it previously held in solution. Alkalies combine with it readily, and saturate its excess of acid. They resist its tendency to spontaneous decomposition, and retain in solution its extract.

Deyeux and Vauquelin instituted a set of experiments on the nature of this sap. The former analyzed the sap of the vine and elm, and found in it acetate of lime, acetous acid, and an extract to which he attributed the formation of ammonia, and the spontaneous precipitation of the sap when left exposed to the action of the air. But the analysis of Vauquelin was more minute. In the sap of *fagus sylvatica* he found the following ingredients: Water, acetate of lime, with excess of acid, acetate of potass, gallic acid, tannin, mucous extractive matter, and acetate of alumina. In 1039 parts of the sap of *ulmus campestris*, he found 1.027 parts of water and volatile matter, 9.240 of acetate of potass, 1.060 of vegetable matter, 0.796 of carbonate of lime, besides some slight indications of the presence of sulphuric and muriatic acids; and at a later period of the season he found the vegetable matter increased, and the carbonate of lime and acetate of potass diminished. From the above experiments, therefore, as well as from those of other chemists, it is plain that the sap consists of a great variety of ingredients differing in different species of plants, though there is too little known concerning it to warrant the deduction of any general conclusions, as the number of plants whose sap has hitherto been analyzed is yet but very limited. It is the grand and principal source of vegetable aliment, and may be regarded as being somewhat analogous to the blood of animals. It is not made use of by man, at least in its natural state; but there are trees, such as the birch, whose sap may be manufactured into a very pleasant wine; and it is well known that the sap of the American maple tree yields a considerable quantity of sugar. Boussingault has lately examined the sap of the *musa paradisaica*. It is limpid like water. When left exposed to the air it lets fall red flakes. It stains linen; but loses this property by exposure to the air. It contains tannin, gallic acid, acetic acid, common salt, and salts of lime, potash, and alumina.

The proper juice. After the sap has passed into the leaves, and has thus communicated with the atmosphere, it becomes elaborated into what is called the proper juice, and descends again through the vessels of the stem. This fluid is distinguishable from the sap by a difference of colour, as well as qualities. Thus in the periwinkle it is green, in logwood red, white in spurge, and yellow in the celandine, from the two last of which it may readily be obtained by breaking the stem asunder, as it will then exude from the fracture. Its principal seat is in the bark, where it occupies the simple tubes; but sometimes it is situated between the bark and wood, as in the juniper tree; or in the leaf, as in the greater part of herbs; or it is diffused throughout the whole plant, as in the fir and hemlock, in which case either the proper juice mixes with the sad, or the vessels containing it have ramifications so fine as to be altogether imperceptible. It is not, however, the same in all plants, nor even in the different parts of the same plant. In the cherry it is mucilaginous, in the pine it is resinous, in spurge and celandine it is caustic, though resembling in appearance an emulsion. In many plants the proper juice of the bark is different from that of the flower, and the proper juice of the fruit different from both. Its appearance under the microscope, according to Senebier, is that of an assemblage of small globules, connected by small and prism-shaped substances placed between them. If this juice could be obtained in a state of purity, its analysis would throw considerable light on the subject of vegetation; but it seems impracticable to extract it without a mixture of sap. Senebier analyzed the milky juice of *euphorbia cyparissus*, of which he had procured a small quantity considerably pure, though its pungency was so great as to occasion an inflammation of the eyes to the person employed to procure it. It mixed readily with water, to which it communicated its colour. When left exposed to the air a slight precipitation ensued; and when allowed to evaporate, a thin and opaque crust remained behind. Alcohol coagulated it into small globules. Ether dissolved it entirely, as did also oil of turpentine. Sulphuric acid changed its colour to black, nitric acid to green. The most accurate experiments on the subject are those of Chaptal. When oxymuriatic acid was poured into the peculiar juice of *euphorbia*, a very copious white precipitate fell down, which, when washed and dried, had the appearance of starch, and was not altered by keeping. Alcohol, aided by heat, dissolved two kinds of it, which the addition of water again precipitated. They had all the properties of resin. The remaining third part possessed the properties of woody fibre. The same experiment was tried on the juice of a variety of other plants, and the result uniformly was, that oxymuriatic acid precipitated them from woody fibre.

The peculiar qualities and virtues of plants seem to reside in their proper juice. Thus the juice of the poppy is narcotic, furnishing opium. The stimulating and diuretic effects of the fir are in its turpentine. Cinnamon and other aromatic shrubs yield a highly pungent essential oil. The resinous juice of the jalap is a purgative. Sugar is the sweet juice of the sugar cane, the maple tree, and the beet root. The bark of trees contains this juice in greatest abundance, as is ex-

emplified in the cinnamon tree and camphor tree. The peach tree, however, furnishes an exception to this rule. Its flowers are purgative, and the whole plant aromatic; but its juice is without any distinguished virtues.

Malpighi regarded the proper juice as the principle of nourishment, and compared it to the blood of animals; but this analogy does not hold very closely. The sap is, perhaps, more analogous to the blood, from which the proper juice is rather a secretion. In one respect, however, the analogy holds good, that is, with regard to extravasated blood and peculiar juices. If the blood escapes from the vessels, it forms neither flesh nor bones, but tumours; and if the proper juices escape from the vessels containing them, they form neither wood nor bark, but a lump or deposit of inspissated fluid. To the sap, or to the proper juice, or rather to a mixture of both, we must refer such substances as are obtained from plants under the name of expressed juices, because it is evident that they can come from no other source. In this state they are generally obtained in the first instance, whether with a view to their use in medicine, or their application to the arts. It is the business of the chemist, or artist, to separate and purify them afterwards, according to the peculiar object he may happen to have in view, and the use to which he purposes to apply them. They contain, like the sap, acetate of potass or of lime, and assume a deeper shade of colour when exposed to the fire or air. The oxymuriatic acid precipitates from them a coloured and flaky substance, as from the sap; and they yield by evaporation a quantity of extract; but they differ from the sap in exhibiting no traces of tannin or gallic acid, and but rarely of the saccharine principle.

Ashes. When vegetable matter is submitted to the action of fire, all its volatile parts are dissipated, and there only remains a small proportion of incombustible ashes. This ash exhibits a flaky whitish appearance, is soft and crumbling to the touch, and is both tasteless and inodorous. Ashes may be obtained from all parts of the plant, but in different quantities from the same weight, not only in different plants, but in different parts of the same plant. Thus, herbaceous plants, after being dried, yield more ashes than woody plants, the leaves more than the branches, and the branches more than the trunk. The alburnum yields also more ashes than the wood; and putrified vegetables yield more ashes than the same vegetables in a fresh state, if the putrefaction has not taken place in a current of water. The result of Saussure's experiments on this subject was the following:

	Parts ashes.
1000 parts of dried leaves of oak gathered in May, .	53
——— Rhododendrum ferrugineum,	30
——— Esculus hippocastanus, .	72
——— do. do. trunk & branches,	35
——— do do. gathered in Sept.	86
——— do. do. gatherod in Oct.	31
1000 parts dried bark of the oak, . . .	60

This ash is a compound of several ingredients, the principal of which are alkalies, earths, and metals.

Alkalies. Two of the well known alkalies, potass and soda, are obtained from the ashes of plants; but of late years chemists have discovered upwards of thirty distinct alkaline substances in the vegetable juices. These alkalies have been named generally after the plants from which they are derived, as *strychnina*, *atropina*, *quinina*, &c.

Potass. If the ashes of vegetables, burnt in the open air, are repeatedly washed in water, and this water filtered and evaporated to dryness, potass is left behind. The potass of commerce is manufactured in this manner, though it is not quite pure; but it may be purified by dissolving it in spirits of wine, and evaporating the solution to dryness in a silver vessel. When pure, it is white and semi-transparent, and is extremely caustic and deliquescent. It dissolves all soft animal substances, and changes vegetable blues into green. It dissolves alumina, and also a small quantity of silex, with which it fuses into glass with heat. It had long been suspected by chemists to be a compound substance, which conjecture was put beyond a doubt by the brilliant experiments of Sir H. Davy, who proved it to consist of a metallic base, in combination with oxygen.

Soda. This substance is found chiefly in marine plants, and those growing within the influence of salt water. It is obtained from the ashes of burnt fuci, by means of solution in water. Besides the fuci, or sea weed, it is found in great abundance in *salsola soda* and *zostera maritima*. It is generally obtained in the state of a carbonate, and is purified in the same manner as potass, to which it is similar in its general properties, but from which it is easily distinguished by its forming a hard soap with oil, while potass forms a soft soap. It, too, is a combination of a metallic base with oxygen. The importance of this alkali in the arts is very great. It enters into the formation of glass, soap, and various other materials used in the dyeing and manufacture of cloths. They are also of essential importance in medicine.

Earths. The earths which are usually found in vegetables are lime, silex, alumina, and magnesia. Of these, lime is by far the most frequent and abundant, and it is generally found combined with phosphoric, carbonic, or sulphuric acids. The phosphate of lime is, next to the alkaline salts, the most abundant ingredient in the ashes of green herbaceous plants, whose parts are all in a state of active vegetation. The leaf of a tree bursting from the bud contains in its ashes a greater proportion of earthy phosphate than at any other period. One hundred parts of the ashes of the leaves of the oak, gathered in May,

furnished twenty-four parts of earthy phosphate, in September only eighteen parts. In annual plants the proportion of earthy phosphate diminishes from the period of their germination to that of their flowering. Plants of the bean, before flowering, gave fourteen parts of earthy phosphate; in flower only thirteen. Carbonate of lime is, next to phosphate of lime, the most abundant of the earthy salts that are found in vegetables; but if the leaves of plants are washed in water, the proportion of carbonate is augmented. This is owing to the subtraction of their alkaline salts and phosphates in a greater proportion than their lime. In green herbaceous plants, whose parts are in a state of increase, there is but little carbonate of lime; but the ashes of the bark of trees contain an enormous quantity of this earth, and much more than the alburnum, as do also the ashes of the wood. The ashes of most seeds contain no carbonate of lime; but they abound in phosphate of potass; hence the ashes of plants, at the period of the maturity of the fruit, yield less carbonate of lime than at any previous period.

Silica, or flint earth, is not found to exist in great proportion in the ashes of vegetables, unless they have been previously deprived of their salts and phosphates by washing; but when the plants are washed in water, the proportion of their silica augments. The ashes of the leaves of the hazel, gathered in May, yielded 2½ parts of silica in the hundred; the same leaves washed yielded 4 parts in the hundred. Young plants and leaves bursting from the bud contain but little silica in their ashes; but the proportion of silica augments as the parts are developed. This is perhaps owing to the diminution of the alkaline salts. The ashes of some stalks of wheat, gathered a month before the time of flowering, and having some of the radical leaves withered, contained 12 per cent. of silica, and 65 of alkaline salts. At the period of their flowering, and when more of their leaves were withered, the ashes contained 32 parts of silica, and 54 of alkaline salts. Seeds, divested of their external covering, contain less silica than the stem furnished with its leaves; and it is somewhat remarkable that there are trees of which the bark, alburnum, and wood, contain scarcely any silica, and the leaves a great deal, particularly in autumn. This is a phenomenon that cannot be readily accounted for. The greater part of the grasses contain a very considerable proportion of silica, as do also the plants of the genus *equisetum*. Sir H. Davy discovered that it forms a part of the epidermis of these plants, and in some of them the principal part. From 100 parts of the epidermis of the following plants, the proportions of silica were as follows:

Bonnet cane,	90.
Bamboo,	71.4
Common reed,	48.1
Stalks of corn,	66.5

Owing to the silica contained in the epidermis, the plants in which it is found are sometimes used to give a polish to the surface of substances where smoothness is required. The Dutch rush, a plant of this kind, is used to polish even brass.

Alumina. This earth exists in the ashes of several plants, but not by any means so generally, or in such proportions, as lime, or even silica. Saussure found in the ashes of the common fir 14 per cent. of alumina. In many other plants, however, only a trace of it is discoverable. Yet clay earth forms a large, and apparently an indispensable ingredient, in all soils adapted for the support of vegetables.

Magnesia. This earth is also sparingly found in vegetables. It is confined chiefly to marine species, as the fuci. Vauquelin obtained 17 per cent. of magnesia from the ashes of *salsola soda.*

Metallic oxides. Some of the metals exist in minute proportions in the ashes of vegetables, such as gold, magnesia, and iron. The latter is by far the most common. It occurs in the state of an oxide; and the ashes of hard and woody plants, such as the oak, are said to contain nearly one-twelfth part their weight of this oxide. The ashes of *salsola* contain also a considerable quantity. The oxide of magnesia was first detected in vegetables by Scheele, and afterwards found by Proust in the ashes of the pine, vine, green oak, and fig tree. It has been stated, too, that minute portions of gold have been detected in vegetable bodies. Saussure remarks that the properties of the oxides of iron and of magnesia augment in the ashes of plants as their vegetation advances. The leaves of trees furnish more of these principles in autumn than in spring. It is so also with annual plants. Seeds contain metals in less abundance than the stem; and if plants are washed with water, the proportion of their metallic oxides is augmented.

Decomposition of vegetables. During the spontaneous decomposition which all vegetables, in common with all organized bodies, undergo, it is obvious that the simple substances of which they are composed must unite together in a different manner from that in which they were formerly united, and form a new set of compounds which did not formerly exist. Now it has been remarked, that the specific gravity of these new compounds is almost always less than that of the old body. Some of them usually fly off in the state of gas or vapour; hence the odour that vegetable bodies emit during the whole time that they are running through the series of their changes. When the odour is very offensive or noxious, the spontaneous decomposition is called putrefaction; but when the odour is not offensive, or when any of the new compounds formed is applied to useful purposes, the spontaneous

decomposition is called fermentation. Fermentation never takes place unless vegetable substances contain a certain portion of water, and unless they are exposed to a temperature at least above the freezing point. When dry or freezing, many of them continue long without alteration. There are three kinds of fermentation. The vinous, where saccharine matter is converted into intoxicating liquors, as wine, alcohol, &c.; the acetous, where fermented liquors undergo a further change into vinegar; and the panary, where amylaceous matter is converted into bread. As these different kinds of fermentation come to be treated of at length under the heads of the vegetable products which yield them, we shall return to the subject in a subsequent part of this work.

CHAP. XXII.

GEOGRAPHICAL DISTRIBUTION OF PLANTS.

The surface of the earth, with very few exceptions, presents the aspect of a natural garden, teeming spontaneously with vegetable productions of every variety of form, of hue, and magnitude. Notwithstanding the extremes of temperature, from the fervid glow of the tropics to the chill atmosphere of the polar regions, there are yet vegetable forms adapted to every climate; and there is no region almost so cold, or arid, or steeped in moisture, which has not its appropriate vegetation. It has in consequence become a question with the observers of nature, by what means all these varieties of families and species have obtained possession of their present localities; and why it is that the banks of the Orinoco are fringed with trees and herbs whose counterparts we should in vain seek on the margin of the Rhine; that out of 7000 species of flowering plants found wild in Europe, not a hundred have been seen in Australasia; that the Alps of Switzerland, and mountains of Nepaul, produce perhaps not a greater number common to both; and in short, that every country of considerable extent has certain species to distinguish it from others. Investigations concerning the original creation of plants, in the present state of human knowledge, might be deemed by many at best an idle waste of time; and even inquiries into the means by which they occupy their present situations, except in some few particular instances, may truly seem a speculation not much more profitable in itself, or likely to arrive at ultimate success.

This inquiry, nevertheless, has occupied the attention of many eminent botanists, and has led to considerable diversity of opinion amongst them; one party supposing all plants to have originated in some central point, from which they have been gradually spread over the earth's surface; others conceiving that several of such centres must have existed; and a third party believing species, for the most part, to have originated where they now appear, as the natural and untransported products of the soil and climate. Some again suppose that at first only *genera* existed, species arising from generic admixture; while others maintain that all vegetable forms are modifications of each other, or the result of a certain concurrence of molecules dispersed through matter, hence liable to be produced in any situation where the necessary conditions of their existence occur.

The causes, says Mr Watson, now visibly operating in the extension of species, from one part of the earth to another, afford us a more tangible subject for inquiry. Millions of seeds are annually ripened and dispersed abroad by the agency of the winds, currents of water, or animal locomotion; and though doubtless a very large proportion of them may be either entirely lost, or being carried into situations unfavourable to their development, may long remain unchanged; yet some among them must occasionally be dispersed under more favourable circumstances, and the conditions requisite for their vegetation being supplied, they are forthwith developed, and add an additional species to the flora of the district to which they have been carried. How much of vegetable distribution has thus been effected it is quite impossible now to estimate; but any observer may have evidence that such causes are still operative in our flora, although, perhaps, not very materially altering the range of its species, except when the interference of human agency is also introduced.

When man transports the vegetable forms of distant regions to his own home, then it may, and does really happen, in Britain for instance, that their ripened seeds, dispersed by the wind, or carried to a distance by streams, spring up, grow, and produce other seeds, to be again scattered farther, until a species once unknown to the country, next limited to one small spot only, is spread over its surface, and at length comes to be regarded as a part of its flora. The turnip, parsley, canary grass, beech tree, and many others, have been thus introduced to Britain. Mr Winch enumerates nearly fifty species not included in the catalogues of British plants, which are nevertheless occasionally found wild on the ballast hills of Northumberland and Durham, to which they have been carried by shipping. The different kinds of corn, the grape, the sugar cane, the bread fruit, the potatoe, and the coffee shrub, have thus been more or less extensively spread over the earth; and the wide waste of waters, formerly bounding the progression of species, by the restless ingenuity of man

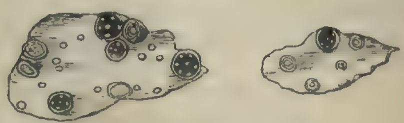
has been made a road of communication, over which the plants of Europe may pass to America, and those of America be in turn transported to the fields of Europe; by means of which New Holland may send her snowy and fantastic forms to adorn the lawns and conservatories of Britain, receiving in exchange the not less valuable productions of her farms and culinary gardens.

But it is not sufficient for vegetation that the seeds and roots of plants be merely transported from place to place by the agencies already mentioned. Unless carried to a congenial climate and soil, they sooner or later perish, and again disappear from a country unadapted to their nature. Year after year living seeds are carried from the shores of tropical America, and deposited, by the gulf stream, on the coasts of Europe, without securing to themselves any permanent existence in its flora; and of our cultivated exotics, how few have become even imperfectly naturalized? What then, it may be inquired, are the conditions necessary to the successful development of vegetation, and its unaided continuance by descent? Undoubtedly they are various, both in kind and degree, each particular species, perhaps, requiring some modification of the general conditions. In Britain how often do we see a sharp frost of spring, or early summer, lay prostrate the gayest beauties of the garden, yet spare the humbler flowers that adorn unbidden our fields and groves. Continued drought at times converts the fresh verdure of an English landscape into brown aridity. And while the sheltered valley may be adorned with lofty trees, on the exposed hills that bound it, these forest monarchs, crouching before the blasts of heaven, are scarcely able to raise their distorted and ungraceful boughs a few feet above the surface of the ground. Again, the clear stream and stagnant morass, the porous gravel and the adhesive clay, the saline soil of the coast, and the vegetable earth of the peat bog, are each distinguished by some peculiarities in the plants they produce; and when by any chance the species flourishing on one of these soils are transferred to another, their feeble growth and altered habit frequently prove sure evidences how little their new situation is congenial to them.

Certain conditions, then, of the atmosphere, as regards temperature and moisture; of the soil, as regards qualities and composition; and of their situation, as regards altitude, exposure, and shelter—all influence the distribution and localization of plants.

Temperature. Geographers have divided the globe into zones, corresponding to the modifications of heat on its surface. Generally speaking, the temperature diminishes from the equator, where it is greatest, to the poles, where the mean heat of the sun is least. Vegetation also follows this course with regard to particular kinds of vegetation. The torrid zone is the region of palms; the temperate zones of oak and other magnificent trees of the forest. As we reach the extremities of the temperate zone, and under those of the frigid, pines, birches, and other hardy trees only thrive. At last we come to a region of heaths and lichens; these, too, begin to disappear on the verge of the snow line; and at last extreme cold shuts out vegetation altogether. The plant which is found to approach nearest to the pole, and which there is good reason to believe even reaches it, is the *palmella nivalis*, or

72.



red snow, a minute cryptogamic plant, which is found incrusting the surface of the snow like drops of blood.

In considering the influence of temperature, however, it must be remarked that the degree of heat does not regularly coincide with the latitude or distance from the equator. Various causes tend to modify the heat both of the earth and atmosphere; such as long ranges of continent or of ocean, and locality as regards the eastern or western sides of islands or continents.

Altitude has also an effect on temperature, and on the localization of plants. As elevated situations are colder than others on a level with the ocean, the higher we ascend mountains the lower the temperature becomes, till at last we reach their summits tipt with snow; and thus we experience a change of climate corresponding to that which takes place between the equator and the poles. A similar change of vegetation is also observable. Thus, in ascending the Alps or Pyrenees, we find the oaks and vines characteristic of a temperate climate around their base. A little higher these have disappeared; but pines, birches, and alders, still remain. Still higher, the absence of trees, while there yet appear small willows and heaths, with many mosses and saxifrages, recalls the treeless flora of the polar regions. Many of the plants found high on the mountains of South Europe, are indeed specifically the same as those of Spitzbergen and Greenland. Below them we have Lapland species; lower still those of Britain. Nearly one half of the plants of Spitzbergen are found on the hills of Scotland; those of England, lower in height, have only one-fourth. The altitude at which perpetual snow lies on the mountains of the equator is about 16,000 feet, becoming lower as we advance to the poles, and resting on the sea level in 70° or 80° north latitude; but the height of this snow line varies greatly from local circumstances. As

a general rule, it may be said to depend on the temperature of summer more than that of the whole year, and is, therefore, lower in maritime countries than in continental.

Moisture and soil. Some plants require a much greater proportion of moisture than others; and thus we find some thriving on the sandy rocks, while others luxuriate in the marsh, or banks of the lake or river. Moisture depends no less on the state of the atmosphere, and the prevailing currents of winds in the district, than on the nature of the soil. The quantity of moisture influences much the vegetation of a country. Marshes tend to increase rushes; frequent rains, the grasses and cryptogamic plants.

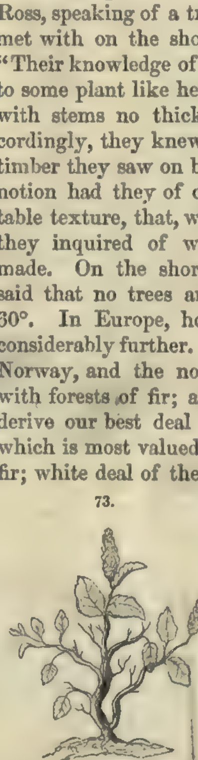
Aspect. Under this term are included shelter *from*, or exposure *to*, particular winds, sun, light, air, &c. Some plants grow best on sunny banks; others scarcely exist save in the deep gloom of the forest; some bear the chafings of the rudest winds, by which others are immediately destroyed. Several species in southern latitudes, or at low elevations, will only grow in shaded places; while higher up, or farther north, they woo the sun. The summits of hills have a more rigid vegetation than vallies of an equal altitude; and the shores of the sea rarely show trees of so vigorous growth as inland situations. A small belt of trees, planted in an exposed situation, generally fails; while a large compact mass succeeds, though often at the expense of those on the outside.

We shall now proceed to offer a general view of the distribution of vegetables over the globe.

Scarcely fourteen hundred species of plants appear to have been known and described by the Greeks, Romans, and Arabians.* At present, more than three thousand species are enumerated as natives of our own island; and the researches of botanists in other parts of the world, have extended our knowledge of the vegetable kingdom to at least 50,000 species. Of this vast number, comparatively few belong indiscriminately to all climates and situations; none, perhaps, excepting some mosses and other obscure plants, which appear to require for their existence only an abundance of shade and moisture. This limitation of particular plants to certain latitudes, is undoubtedly connected with certain peculiarities in their internal structure; though for the most part, we are unable to discover in what those peculiarities consist. Independently, however, of the restriction thus imposed by the climate of every place on the nature of its vegetable productions, each of the great divisions of the earth appears to have given birth to a set of plants distinct from those of other parts. Thus, a large proportion of the trees and plants growing wild in the western hemisphere, are unlike those of the eastern hemisphere in the same latitude. The vegetable productions of the Cape of Good Hope are unlike those of the south of Europe, though the climate in these two situations is little dissimilar. The plants of the East Indian islands form another distinct class; those of China and Japan another; those of New Holland again another. The little island of St Helena contains a set of plants peculiar to itself, not one of which is to be found on the neighbouring western shore of the continent of Africa. The plants originally belonging to one part of the world, when removed to another enjoying a similar climate, often appear to flourish as well as in their native soil. Thus the potatoe, a native of South America, which was brought to England by Sir Walter Raleigh, in the reign of queen Elizabeth, grows as well here as the turnip, the carrot, or the cabbage, which are natives of Great Britain. In like manner do the sugar-cane and the coffee-tree flourish in the West Indies, though not originally produced there, but transplanted, the sugar-cane from China, the coffee-tree from Arabia.

It will be convenient to begin our survey of the vegetable kingdom from the colder regions of the earth, and to proceed gradually towards the warmer. Beyond the arctic circle, the number of plants is extremely limited. Captain Ross, speaking of a tribe of Esquimaux that he met with on the shores of Baffin's Bay, says: "Their knowledge of wood seemed to be limited to some plant like heath, of a dwarfish growth, with stems no thicker than the finger." Accordingly, they knew not what to think of the timber they saw on board the ship; and so little notion had they of cloth, or any kind of vegetable texture, that, when presented with a shirt, they inquired of what animal's skin it was made. On the shores of Hudson's Bay, it is said that no trees are found north of latitude 60°. In Europe, however, vegetation extends considerably further. A great part of Sweden, Norway, and the north of Russia, is covered with forests of fir; and from these countries we derive our best deal timber. The yellow deal, which is most valued, is the wood of the silver fir; white deal of the spruce fir.

73.



Dwarf Willow.

In no part of the world has the distribution of plants been more carefully observed than in Norway and Lapland. The trees which are there found to approach nearest the limits of perpetual snow are the dwarf birch and dwarf willow, if they can be properly denominated trees; the dwarf birch seldom exceeding two or three feet in height, and the dwarf willow being

* Barton on Geographical Distribution of Plants.

still smaller: so small, indeed, that half a dozen plants, with their roots, stem, branches, and leaves complete, may be laid out on the page of a duodecimo volume. Even beyond the limit of these trees are found, however, several small plants; and among them one which particularly deserves to be noticed—the reindeer moss, which forms the principal food of the reindeer, an animal employed by the Laplanders both for drawing their sledges for food, and for milk. In the winter, when the ground is covered with snow these sagacious creatures dig with their feet to get at the moss beneath. When boiled in water, this moss affords a nutritious jelly, which has been employed as a remedy in consumptive complaints.

74.

Next after the dwarf birch and dwarf willow, come the common birch, the mountain ash, and the Scotch fir, with two or three other species of willow; then a species of alder, which has been called the cold alder, from its peculiar place of growth, not being found south of latitude 60°; the bird cherry, and the aspen, the gooseberry and the raspberry. Still travelling towards the south, we arrive successively at the northern limit of the ash, the oak, and the beech. The northern limit of the oak has been traced throughout Europe. At Dronthiem, in Norway, on the coast of the Atlantic ocean, this tree is found in latitude, 63°; in the eastern part of Europe, on the confines of Asia, it ceases to grow in latitude 57½°; a remarkable proof of the superior mildness of the climate on the western shore of the old continent, as compared with that of the interior; for it is by no means true, as generally supposed, that the climate of the sea coast is universally milder than that of the interior. If we pursue the limits of vegetation through Asia, to the eastern extremity of the continent, we shall find the cold little, if any thing diminished, as we approach the shores of the Pacific ocean. The oak languishes on the banks of the Argoun, towards the east of Asiatic Russia, in the latitude of London, eight hundred miles nearer to the equator than the point at which it ceases to grow on the opposite shore of the continent. At Pekin, in China, situated only fifty miles from the sea coast, (in the latitude of the south of France, where orange trees grow without protection in the open air,) the severity of the winter's cold far exceeds that experienced in any part of Great Britain, and falls short only two or three degrees of that at North Cape, the furthest extremity of Europe. When we speak of the mildness of a maritime climate, we must therefore keep in mind that the expression applies only to the western, not to the eastern shores of the continent.

It is easy to comprehend why the neighbourhood of the sea, in countries situated far north, should tend to render the climate milder, while in the tropical regions it moderates the intensity of the heat, since it is known that the temperature of the ocean varies much less than that of the land; the waters from the equator being continually mixed with those of the Polar regions by the current of the gulf-stream. Why the inhabitants of the eastern shore do not enjoy this advantage, as well as those of the western shore of the continent, is in part explained by the prevalence of westerly winds in these latitudes; a westerly wind bringing with it the warm and humid atmosphere of the Atlantic to the inhabitants of Iceland and of Norway, while it brings the dry and cold atmosphere of Siberia to the inhabitants of Kamschatka and Corea.

Norway and Lapland enjoy a more temperate climate than any other country in the same latitude. The Scotch fir there attains to a height of sixty feet in latitude 70°; and at Tornea, at the head of the gulf of Bothnia, in latitude 66°, the birches are described by Von Buch as *magnificent*. For this superiority of climate, these countries are probably indebted to their peculiar position between four seas, the Atlantic, the Arctic ocean, the White sea, and the gulf of Bothnia. A very curious difference has, however, been observed between the climate of Lapland, lying to the north of the gulf of Bothnia, and that of Norway, which skirts the shore of the Atlantic and Arctic oceans. These two countries are separated by a chain of mountains of considerable elevation, which fall abruptly and precipitously towards the sea on the northern and western sides, and descend with a gentle and gradual slope towards the gulf on the other side. Norway, exposed to the moist and temperate atmosphere of the ocean, enjoys a singularly mild winter, but receives little of the sun's rays in summer; partly from the humidity and mistiness of the air, partly from the declivity of the land towards the north. Lapland has a colder winter, but a warmer summer. And, accordingly, it is found that such plants as require only a few weeks of warm weather to bring them to maturity succeed in Lapland, though they will not grow in Norway; while those which are easily killed by a severe frost flourish better in Norway than in Lapland.

For the sake of distinction, that kind of equable climate enjoyed by the countries bordering on the Atlantic, has been called the *Island Climate*. It belongs, perhaps, still more strikingly to Ireland and the west of Scotland, than to Norway. The other sort of climate, where both the summers are hotter, and the winters

colder, is called the *Continental Climate;* and as Lapland possesses it in a greater degree than Norway, Russia possesses it in a still greater degree than Lapland. We shall hereafter see that similar differences have been found to prevail between the maritime and inland districts in other parts of Europe.

In the Orkney islands, off the northern coast of Scotland, no tree is found but the hazel, which seems to bear the winds of the Atlantic better than either the Scotch or the spruce fir. On the coast of Norway, the hazel and the spruce fir terminate nearly at the same point. In Sweden, on the coast of the Baltic, the spruce fir is found eight degrees nearer to the Pole than the hazel. Travelling still towards the east, we lose the hazel altogether, soon after entering the confines of Asia; and it is not met with again in any part of Siberia till we reach the river Amur, near the shores of the Pacific ocean. Again, in Scotland there are extensive natural woods of the Scotch fir, but none of the spruce fir. On the coast of Norway, the spruce fir terminates at latitude 67°, but the Scotch fir extends to latitude 70°, and the birch nearly to 71.° In Siberia, the spruce fir and the larch (the latter unknown in Norway and Sweden) extend further to the north than either the Scotch fir or the birch. On the limits between Asia and Europe, the mountain ash, aspen, black alder, and juniper, which in Norway grow under the Polar circle, scarcely reach the 60th degree.

It happens in Lapland, as in some other parts of the world, that the limits of vegetation are determined more by the form and disposition of the neighbouring mountains than by the latitude. The lines which separate the growth of the different species of plants, are disposed in semicircles round the head of the gulf of Bothnia; each semicircle rising above the other, as we ascend towards the chain of the *Dofrines.* In the first, or lowest band, the prevailing tree is the spruce fir; and to this region, for the most part, the cultivation of corn is confined. Above this grows the Scotch fir, and above the Scotch fir the dwarf birch and willow. At the height of 2500 feet, the dwarf birch just finds sufficient warmth, about the end of June, to put forth three leaves from each bud, which in a few weeks wither and fall off again; yet this feeble effort of vegetation is found sufficient to continue the life of the plant. It has been observed, that the leaves of the birch unfold whenever the temperature of the air rises to 52°: in situations, therefore, where the heat of the warmest month does not rise to this point, it is incapable of growing.

During the short but warm summer of Lapland, vegetation proceeds with extraordinary rapidity. Until the middle of May, the ground is covered with snow. About a month later, the rivers begin rapidly to swell, in consequence of the breaking up of the frost. In the beginning of October the ground is hard frozen, and remains so from seven to eight months. Such is the climate of *Enontekeis,* which is situated in the higher and colder part of Lapland. It is not till the month of June that barley can be sown; yet, in the short space of three months, the fields are ready for the harvest. It has been found that the cultivation of this grain succeeds wherever the mean temperature during ninety days rises to 48°.

Notwithstanding its northern and inclement climate, Lapland has to boast of some wild flowers of great beauty. Among these are the mezereon, the yellow and white water lily, and the European globe flower. As we travel southward along the shores of the Baltic, towards Stockholm, we find, for the first time, in Angermanland, the wood anemone, the hepatica, the dog rose, and the sycamore;—in Medelpad, the burdock, and the *campanula persicifolia;*—in Gastrickeland, the cowslip, the guelder rose, the *spiræa filipendula,* and the hazel. At the river Dal we find the *anemone pulsatilla,* the hawthorn, and the sloe. Here we lose the hoary or cold alder. Several of these plants extend further north on the sea shore than inland; owing, as it would appear, to the greater mildness of the maritime climate.

A great part of the Russian empire, both in Europe and Asia, is covered with forests. In the northern provinces are found principally the various species of firs; the Scotch and spruce fir, the larch; and towards the Ural mountains the Siberian cedar. Of deciduous trees, the most abundant is the birch; and next to this the lime tree, of whose inner part the common garden-mats are made; and shoes, platted from the rind of the young shoots of this tree, are generally worn by the common people in Russia. The beech, elm, and poplar, are chiefly the growth of the southern provinces. Such was the abundance of wood, till of late years, in this country, that the peasants were for the most part allowed to cut down as much as they pleased. It is, indeed, by the produce of the forests, that the people of the northern provinces chiefly live. Their houses are almost universally constructed of timber; wood is every where used for fuel; and they employ a slip of birch-wood, lighted, for a candle. From the ashes of trees, cut down and burnt for this purpose, they obtain potash, of which large quantities are annually exported. For the purpose of tanning, the Russians employ not merely the bark of the oak, but of the birch and willow. From the wood of the birch they procure a species of tar, which is used in dressing that kind of leather commonly known by the name of Russia leather, and much employed in book-binding.

As we pass into Asiatic Russia, we succes-

sively lose the oak, the hazel, the ash, the lime tree, the Scotch fir, the spruce fir, and the Siberian cedar; while the larch extends to the shores of the Arctic ocean. In the southern parts of Siberia are found wild tulips, anemones, two species of rhododendron, and the scarlet lychnis. To the east of lake Baikal, the European globe flower is replaced by the Asiatic species. In Siberia also grow the cranberry and the hautboy strawberry.

The oak, the beech, and the elm are natives of Great Britain. Each of these trees has its appropriate soil. In the western part of the county of Sussex, we have three distinct belts of country, each strongly marked by the character of its vegetation. To the north we have a strong and deep clay, admirably adapted to the growth of oak. Then come the chalk hills, where the luxuriant growth of the beech attests that this tree has found its congenial soil. This tree is not met with north of Stamford in Lincolnshire. The elm seen in Scotland and the north of England is the wych elm, a different species, growing in a more straggling form, with pendent branches, and a larger leaf. Its wood is very unlike that of the English elm; more resembling that of the ash. In the approach to some of the royal palaces in Spain, are some rows of elm, which, we are assured by Evelyn, were transplanted from England by Philip II., the husband of queen Mary of England, the elm not being a native of Spain. In addition to the trees just mentioned, the ash, the maple, the sycamore, and the small-leaved lime tree, may be enumerated as growing wild in Great Britain.

If we now turn our attention to the countries occupying the southern side of the Baltic, we shall find a wide district of *heath*, beginning from the northern extremity of Jutland, extending as far south as latitude 52°; thence westward as far as the ocean, and eastward over a considerable part of the north of Germany. In this barren tract, the few spots which have been brought into cultivation by human industry appear like green islands amidst the waste. The variety of species of heath found in this tract is very small; and few, if any of them, are strikingly beautiful. In the wet and springy parts of the district are many tracts of bog, or peat moss, scarcely less sterile than heath. Occasionally, however, the cranberry, and some other eatable berries of the same family, as the *bilberry* and the *whortleberry*, cover the surface; and the substance of the bog itself furnishes a kind of fuel to the poor inhabitants, after being cut in small square pieces, and piled in stacks to dry. When attentively examined, it is found to consist of vegetable fibres, partially decayed, and compacted by the pressure of the superincumbent portion. Its composition is only to be seen, however, in that part of the bog which lies toward the surface; towards the bottom it takes the appearance of a black and solid mass. In many places the natural soil is covered to a depth of twenty or thirty feet with this substance. The plants by whose decomposition these bogs are formed, appear to be principally two or three kinds of moss. These are almost invariably found growing on the surface; and it appears that each generation, as it dies, forms a soil for that which is to succeed. That a continual growth really takes place, is proved by the gradual filling up of the hollows excavated for obtaining fuel. Much of the surface of Scotland, the north of England, Wales, and Ireland, is covered with these bogs, as well as of that part of the continent of Europe which touches the shores of the German ocean and the Baltic.

To the south of this barren tract of heath and peat moss, we find an extensive region of remarkable fertility, in which every species of our cultivated grain flourishes. This district, which is for the most part unbroken by hills of any considerable height, comprises the Netherlands, the greater part of France, the middle of Germany, Poland, and southern Russia. The eastern part of this region being comparatively thinly peopled, supplies with corn several other parts of Europe; the produce of the soil being carried down by internal navigation, partly to the ports on the Baltic, partly to those on the Black sea.

The line which limits the cultivation of corn, like that which limits the growth of the oak and other forest trees, extends much further north on the western side, than on the eastern side of the continent. In Norway, barley sometimes ripens, in favourable aspects, under the 70th parallel of latitude. In European Russia, the cultivation of corn scarcely succeeds beyond latitude 60°; and in Kamschatka, the eastern extremity of Asia, this limit descends as low as 51°, the latitude of London. On the eastern shore of the continent of America, the growth of corn does not extend beyond latitude 52°. Wheat demands a warmer climate than barley or oats. This grain is not found to succeed so well in the west of Scotland, the summer's sun being insufficient to ripen it. Even in England, the western side of the island appears better adapted to the growth of grass than of corn; and accordingly, it may be observed, in every part of the kingdom, that corn is carried from east to west, while cattle are driven from west to east. All our principal corn counties are situated on the eastern side of the island, from the Lothians, in Scotland, to Kent, the south-eastern county of England. This is to be attributed, in a great measure, to the humidity of the climate in those districts bordering on the shores of the Atlantic.

The cultivation of corn does not succeed better in the torrid zone than in the polar regions.

Within the tropics, wheat, barley, and oats, are not cultivated, excepting in situations elevated considerably above the level of the sea.

The cultivated apple is thought to be a variety of the crab, and may therefore be considered a native of England. This fruit does not ripen north of Sundswall, in Sweden, in latitude 62°, nor in the east of Europe, beyond latitude 57°. Its near relations, the pear and the quince, are not natives of England, but are found wild in the southern parts of Europe. The quince scarcely succeeds in the northern counties of England. It has not been known to ripen its fruit beyond the Tees more than twice in twenty years, though it flowers freely. The medlar, the walnut, and the chestnut, succeed no better; and even the filbert bears very sparingly. The vine seldom flowers; and if, by chance, small grapes are produced, they soon drop off. The mulberry is there a low, stunted tree; but in hot summers bears abundance of small fruit, which in part comes to maturity, and is well flavoured.

We are thus able to assign the northern limit to the cultivation of most of our common fruits. But if we pursue the same inquiry on the western side of the kingdom, following the line of the coast from Cumberland to Cornwall, we shall arrive at some very extraordinary and unexpected results; results which serve remarkably to illustrate the peculiarities of an island climate. At the further extremity of that long promontory, which, projecting into the Atlantic, forms at once the most southern and the most western point of England, neither the apricot, the vine, nor the greengage plum, produce ripe fruit, for want, as it should appear, of sufficiently powerful sunbeams. Yet such is the mildness of the winter, that the myrtle, the camellia, and other greenhouse plants, grow luxuriantly in the open air; and the ponds are seldom sufficiently frozen to bear the weight of a man.

An analogous observation was made by Arthur Young, nearly forty years ago, with regard to the climate of France. Having, in the course of several tours through that kingdom, minutely observed the agricultural productions of its different provinces, he found that the lines which form the northern boundary of the cultivation of the vine, maize, and olive, follow an oblique direction from south-west to north-east; an observation which appears, at first sight, strangely at variance with the known mildness of maritime climates. But the apparent contradiction disappears, when it is considered that the ripening of fruit and of grain depends altogether on the force of the sun's rays in summer, and is not affected by the severity of the winter. Now, as before observed with regard to Lapland and Norway, the interior of the continent of Europe enjoys a hotter summer than the coast, though it has to endure a colder winter. It would be wrong, however, to suppose that the line drawn by Arthur Young, as limiting the cultivation of the vine in France, extends throughout the continent of Europe in the same direction. In that case it would reach to Moscow, in latitude 56°; whereas vineyards are unknown in Russia to the north of latitude 50°; which is precisely the extreme limit of the cultivation of the vine in France. According to Malte-Brun, a line of separation between the countries in which wine forms the principal drink of the people, and those in which they principally consume beer, may be drawn from the south of England through French Flanders, Hesse, Bohemia, the Carpathian mountains, Odessa, and the Crimea. This line, it will be observed, is not exactly the same as that which limits the cultivation of the vine. Something must be allowed for national custom. The people of the north-western part of France drink wine, though not produced on the spot, but brought, at a considerable expense, from the more southern provinces, because, to a Frenchman, habit has rendered wine one of the necessaries of life. The Russians, on the other hand, accustomed to beer, do not drink much wine, even in those southern districts where the climate admits of the cultivation of the grape.

Humboldt estimates that the cultivation of the vine succeeds only in those climates where the annual mean temperature is between 50° and 63°; or the mean temperature may even be as low as 48°, provided the summer heat rises to 68°. In the old world these conditions are found to exist as far north as latitude 50°; in the new world, not beyond latitude 40°. In both hemispheres the profitable culture of this plant ceases within 30° of the equator, unless in elevated situations, or in islands, as Teneriffe, where the intensity of the heat is moderated by the atmosphere of the sea. Thus the region of vineyards occupies a band of about 20° in breadth in the old world, and not more than half that breadth in America. It may be observed, that the wines produced in the northern part of this region, as those of France and of the Rhone, are lighter and more acid than such as are produced nearer the tropic; owing, probably, to the inferior force of the rays under which the fruit is ripened. In the southern hemisphere, the Cape of Good Hope just falls within the latitude adapted to the grape; and a considerable quantity of wine is annually exported from that settlement. It is of very inferior quality to the wines of Europe and northern Africa, having an unpleasant earthy taste, which is said to arise from the clayey nature of the soil.

In the north of Italy, west of Milan, we first meet with the cultivation of rice. This is the seed of a species of grass, bearded like barley, which, having somewhat of a stiff and reedy foliage, yields a whispering sound when agitated

by the wind. It delights in moisture; and from the time when the blade rises a few inches above the surface, the fields in which it grows are flooded to the depth of several inches by means of artificial water-courses, provided with sluices. The water is not drawn off till the grain is nearly ripe. Three years in succession does the soil yield a crop of rice without manure; it is then suffered to remain two years uncovered with water, during which time it receives one coat of dung, and becomes spontaneously covered with an abundant, though coarse, herbage. Since an acre of rice is worth, on an average, two acres of wheat, it may be supposed how large a profit attends the cultivation of this grain; but so deleterious is the employment to the health of the labourers engaged in it, that the government has prohibited its further extension. Rice can evidently be raised only in situations where the land may at pleasure be covered with water. This is an advantage enjoyed by the whole plain of Lombardy, naturally of great fertility, and rendered still more productive by a system of irrigation more complete, we might almost say more *magnificent*, than is to be found in any other part of the world. Enclosed between two noble chains of mountains, the Alps to the north and west, the Apennines to the south, the deep and rich soil of this plain seems to have been deposited by an inundation which brought down a portion of the substance of those mountains;—consisting, near their bases, of large rounded stones, which gradually diminish in magnitude towards the shores of the gulf of Venice, where the soil consists entirely of finely-divided matter. To the east of Milan this plain is covered with pastures of extraordinary richness, from which is brought the celebrated Parmesan cheese. These pastures are regularly flooded. The grass is cut no less than four times in the year; part is made into hay, and part carried green to the cows, which are kept in stalls. In about fifteen years, the herbage, in consequence of this continual watering, becomes too coarse for use; the land is then ploughed up, and during five years cropped with wheat, oats, maize, hemp, and beans, after which it is again laid down to grass.

This admirable system of irrigation, which has rendered northern Italy the most fruitful country, perhaps, in the world, was established in very early times. It was during the flourishing period of the Lombard republics, about the era of our Norman and early Plantagenet kings, while the greater part of Europe remained yet in a state little short of barbarism, that the design was conceived and executed of this great national work. From each of the lakes that occupy the lower declivities of the Alps, and receive the waters of their innumerable springs, issues one principal canal, which, as it descends, is subdivided into a multitude of smaller channels, visiting every district, every farm, and even every individual field, to each of which the water is admitted at pleasure by sluices; and having performed its office, passes off by another cut to the lower land, till it ultimately reaches the Po, which carries off the whole drainage of central Lombardy into the gulf of Venice. The banks of these canals are mostly planted with willows and alders, over which are frequently seen rows of tall poplars. The principal canals belong to the government; the smaller ones are generally the property of individuals, who let or sell the use of the water at so much per hour.

The cultivation of the olive is bounded to the north by a chain of mountains, extending, with few interruptions, from the Atlantic ocean to the Black sea. This tree is found in every part of Spain and Portugal (with the exception of those districts too much elevated above the level of the sea). It extends over that part of France south of the mountains of the Cevennes; over Italy, south of the Apennines; and Turkey, south of the Hæmus. A traveller from the north, crossing this chain of mountains for the first time, is surprised and delighted at the new aspect of vegetation. Gigantic plants of the grass tribe are seen rising to the height of twenty feet and upwards; the air is perfumed with the blossoms of the orange and lemon tree; the myrtle and pomegranate grow wild among the rocks, with the various species of cistus, that beautiful tribe of plants, which afford such a wonderful succession of flowers, opening every morning, and falling off before the close of the day. The American aloe here blooms in the open air; the

75.

The Dwarf Palm.

chamærops humilis affords the first specimen of the magnificent tropical family of palms; and a few plants may be seen of the date palm of Africa, cultivated only indeed for ornament, since this tree does not produce fruit on the northern side of the Mediterranean. It may perhaps be asserted, without exaggeration, that the appearance of vegetation exhibits a less striking change in travelling northwards from Piedmont to Lapland, than in crossing the Maritime Alps from Piedmont to the gulf of Genoa. On the southern side of those mountains, the vivid green of our meadows and forests is replaced by the dusky tint of the olive and the evergreen oak, which might, perhaps, be termed sombre, if not contrasted with the intensely dark indigo colour of a deep and tranquil sea, undisturbed by tides, and resting on a rocky bottom;—on the other side with the snow-crowned summits of the

mountains, strongly relieved against the azure sky; the whole illuminated by the splendour of an Italian sun. Nor is the olive itself by any means destitute of beauty. It has been compared to a willow; it differs, however, very materially in its colour, having none of that sickly hue of blueish green which gives such a peculiar coldness to the landscapes of some of the Dutch painters. The upper side of the leaf has precisely that tint familiarly known by the name of olive. The under side is of shining whiteness; and as the foliage is turned up by the lightest breeze, its progress over the valleys covered with olive gardens, becomes visible in the form of a silver cloud gliding across the landscape.

According to Humboldt, the olive is cultivated with success in every part of the old world, where the mean temperature of the year is between 58° and 66°; the temperature of the coldest month not being under 42°, nor that of the summer below 71°—73°. These conditions are found, as before observed, in Spain, Portugal, the South of France, Italy, and Turkey. The olive also flourishes on the northern coast of Africa; but is not found south of the Great Desert. In Europe it extends as far north as latitude 44½°; in America, scarcely to latitude 34°, so much greater is the severity of the winter on the other side of the Atlantic. In the neighbourhood of Quito, situated under the equator, at a height of eight thousand feet above the level of the sea, where the temperature varies even less than in the island climates of the temperate zone, the olive attains to the magnitude of the oak, yet never produces fruit.

The inhabitants of the south of Europe employ the oil expressed from the fruit of this tree for the same purposes as we employ butter, and feel at least as much dislike to the produce of the dairy, as an article of food, as we may feel to the use of oil. In this country it is scarcely eaten except with salads, for which purpose it is imported in flasks of very thin glass, covered with basket-work. The fruit of the olive is sometimes gathered in a green state and salted. We are told by Malte-Brun, that if a line be drawn from the Pyrenees, through the Cevennes, the Alps, and the Hæmus, it will separate those countries in which the inhabitants principally make use of butter, from those in which they make use of oil.

The orange and lemon tree are rather more tender than the olive. According to Humboldt, they require a mean annual temperature of 62°. Orange gardens abound at Nice and Genoa, on the borders of the sea, and sheltered by the high range of the Alps to the north; yet they are not to be seen at Florence, or even at Rome, nor do we meet with them again, in travelling through Italy towards the south, till we arrive at Naples. Accordingly it appears, from registers of the daily temperature during the years 1815, 1816, and 1817, that the temperature of the month of December at Nice exceeds that of Rome by 2°, the temperature of January by 3°, that of February by 4°.

The Spanish chestnut abounds in the forests of the south of Europe, and sometimes attains to a great size. On the sides of Mount Etna are some of prodigious magnitude: one of them is named the chestnut of a hundred horse, intimating that it is capable of sheltering a hundred horsemen under its boughs. It is one hundred and ninety-six feet in circumference. The interior is entirely decayed; and a hut is built within the trunk for the habitation of those who are engaged in gathering and preserving the fruit. Another tree found in the southern parts of Europe is the cork tree, a species of oak, whose tough and elastic bark we use for stopping bottles. In the same district are found, growing wild among the rocks, many of the productions of our gardens: thyme, lavender, and rosemary; the cypress, the laurestinus, the arbutus, the bay, and the Judas tree. The laurel appears to be a native of Turkey. The cabbage rose and the damask rose, which appear to have been cultivated in our gardens in very early times, were originally brought from the south of Europe. The evergreen roses, introduced within the last twenty or thirty years, are, as their common name imports, from China. Not one species of rose is found in South America. According to Arthur Young, the culture of the fig and the pomegranate is limited nearly to the same line as that of the olive. The culture of the mulberry, for feeding silkworms, is not marked by quite so well defined a boundary, and appears to extend rather further north.

From the declivities of that long chain of mountains which traverse Europe from west to east, we have received some other of our garden flowers. The auricula, the deep blue gentian, and several species of saxifrage, delight in the elevated regions approaching towards the limits of perpetual snow. From the lower parts of the mountains come the peony, the fraxinella, the black hellebore (sometimes called the Christmas rose), the yellow aconite, and the laburnum. The common blue monkshood, and the yellow monkshood, are also found in this district; but unlike the plants before mentioned, they extend as far north as Sweden, and the latter even to Lapland. The *althœa frutex* is a native of Carniola, on the southern side of the mountains. The beautiful pyramidal bell-flower, bearing a profusion of pale blue flowers, which is often cultivated in pots, and trained in a fan-shape as an ornament to halls and parlours, is from the southern side of the same chain. It is in mountainous regions that the botanist, as well as the

geologist, finds the most abundant harvest; indeed, even the unscientific traveller is struck with the novelty and beauty of the flowers which he finds at every step on crossing the Alps or the Pyrenees. A variety of surface and exposure is favourable to a variety of productions. Some plants prefer the crevices of naked rocks, others the edges of springs, or the banks of clear and rapid streams, others stagnant morasses. All these circumstances are found abundantly in mountainous districts. From these mountain bogs we have obtained a tribe of plants of extraordinary beauty, which, when planted in the same kind of peaty soil as they find in their native spots, are made to flourish tolerably in our gardens. These are the azaleas, rhododendrons, andromedas, and others of the same family.

If from the south of Russia we travel eastward into Asia, the appearance of the country will be found to undergo a very remarkable change. Approaching the northern shore of the Black sea, the soil becomes sandy, intermixed in places with sea-shells, impregnated with salt, and abounding in lakes of salt water. Such is the aspect of the celebrated steppes of Russia. From the low tract lying between the Black sea and the north of the Caspian, these sterile regions extend over a considerable part of central Asia. It has been conjectured that these steppes were once covered by the sea, and the limits of the ancient coast have even been assigned; but the observation can by no means be extended to the salt deserts in the north of Persia and in Independent Tartary.

The presence of salt, in any considerable quantity, is fatal to corn and most other vegetables; there are, however, certain plants to which it appears indispensable, and which have been, for that reason, called saline plants. The sugarcane and the cocoa-nut tree are almost the only plants which flourish equally well when wetted with fresh water or with brine. From the ashes of these saline plants soda is obtained.

Immediately south of that salt plain which occupies the space between the Black sea and the north of the Caspian, is the chain of Mount Caucasus, a most interesting region, both on account of its natural beauties, and of its connection with the earliest authentic records of history. In the fruitful valleys of Curdistan, a Turkish province on the southern side of these mountains, amidst mountains crowned with perpetual snow; and on the banks of the river Gihon (better known by its ancient name of Oxus), which falls into the sea of Aral, on the east of the Caspian, are found whole thickets of lemon, pomegranate, pear, and cherry trees. Every species of fruit cultivated in our gardens grows there apparently wild; but whether they are to be considered as truly natives of the soil, or as being the remains of very ancient gardens, is the more difficult to determine, as this is the spot which appears to have been first peopled by the descendants of Noah. The walnut and the peach we derive from Persia; the vine and the apricot from Armenia; the sweet cherry and the Spanish chestnut from Lesser Asia; from Syria the fig, the olive, and the mulberry. In the triumph of the Roman general Lucullus, after his return from the conquest of Pontus, about a hundred years before the Christian era, was exhibited a cherry tree, loaded with fruit, a sight till then unknown to the inhabitants of Italy. From the same regions we derive the hyacinth, the tulip, the iris, the ranunculus, and some other of our garden flowers, most of which appear to have been first brought into this country during the reign of Elizabeth. To this list may be added the horse chestnut, the lilac, the sweet jasmine, the melon, and the cucumber. That the melon and cucumber were raised in Egypt at a very remote period, appears from the complaints of the Israelites, when they murmured against Moses and Aaron in the wilderness. "We remember the fish," said they, "which we did eat in Egypt freely; the cucumbers, and the melons, and the leeks, and the onions, and the garlick." And in another place they speak of some kinds of fruit now cultivated: "Wherefore have ye made us to come up out of Egypt, to bring us in unto this evil place? It is no place of seed, or of figs, or of vines, or of pomegranates, neither is there any water to drink."

The "wilderness" in which these complaints were uttered by the children of Israel, forms a part of that great sandy desert which bounds to the west the fruitful plain of the Euphrates, extending thence southward over a considerable part of Arabia. In this desert are still to be seen the ruins of Palmyra, supposed to be the city built by Solomon, and named by him Tadmor in the Wilderness. Between the desert and the Mediterranean sea is the "Land of Promise," bounded on the north by Mount Lebanon, still famed for its majestic cedars. The cedar of Lebanon, though now cultivated as an ornamental tree in many parts of the world, has not been found wild except in the mountain from which it derives its name. Again crossing the desert to the extremity of the Red sea, we find a narrow tract of cultivated country along its eastern shore, extending to Yemen the Happy, or Fertile Arabia, the country of balm, frankincense, and myrrh. From Arabia the balm tree was first carried to Judea, as Josephus assures us, by the queen of Sheba, as a present to Solomon; where, being afterwards cultivated for the sake of its fragrant and medicinal juice, particularly on Mount Gilead, it acquired the name of balm of Gilead. Frankincense and myrrh also consist of the dried juices of trees: the same may be said of gum Arabic, which is procured from a species

of mimosa, growing on both sides of the Red sea, as well as in Senegal, and other parts of Africa. The mimosa family is a very numerous one, all of them natives either of the tropical countries, or of the warmer part of the temperate zone. Some of them have the remarkable property of folding up and drooping their leaves at the approach of night, or when touched by any external object, whence they have attained the name of sensitive plants. All of them bear pods, like the pea family; but their blossoms are rather like those of the willow, consisting of little globes of yellow threads. Their leaves (when they produce leaves) are always finely divided, often as much so as those of the carrot, a circumstance which gives to these trees a very peculiar aspect; but a considerable proportion of the mimosas are, properly speaking, leafless, excepting when very young, or after having been injured. The leaf-stalk, however, remains, and assumes a flatted shape, having somewhat of a leaf-like appearance, but differing from a true leaf in its edge being turned towards the stem; its two sides are consequently similar, and perform the same functions with respect to the light. This is particularly the case with the mimosas of New Holland.

Returning to the neighbourhood of the Red sea, we find, on its eastern shores, the native country of the coffee-tree, which is an evergreen, fifteen or twenty feet high, bearing in the bosom of the leaves several white, sweet-scented flowers, of the size of snowdrops. The flower is succeeded by a berry, containing two seeds: these seeds are coffee. In the neighbourhood of the Red sea is found also that species of cassia whose dried leaves are employed in medicine, under the name of senna, and the plant yielding bitter aloes, which must not be confounded with the American aloe cultivated in our greenhouses. Bitter aloes are brought chiefly from the island of Socotra, in the Arabian sea, near the straits of Babelmandel.

In the narrow, but fruitful valley of the Nile, we find several new vegetable productions. Among the most remarkable of these is the papyrus, a species of reed which was employed by the Egyptians in early times for making paper. For this purpose, the inner rind of the stem being cut into strips, and laid together somewhat like matting, was pressed with a weight till the whole adhered together. The papyrus is several feet in height, and bears a sort of tuft or feathery head at the top of the stalk: it grows chiefly in marshy places. In Egypt also grows a species of water lily, called the lotus, of which both the root and the seeds are eatable; and from Egypt was introduced into our gardens the mignonette. This country was once regarded as the granary of Europe, and is still remarkable for its fertility; producing large crops of rice, wheat, barley, and some other species of grain unknown among us; while oats are equally unknown in Egypt; the horses, as in all parts of the East, being fed upon barley.

It will scarcely be necessary to say any thing more of the plants peculiar to Africa, except to mention that its southern extremity (the Cape of Good Hope) has supplied us with a considerable proportion of the most splendid flowers which ornament our greenhouses; particularly the heaths, the geraniums, and the bulbous-rooted plants, comprising the two families of *ixia* and *gladiolus*.

Before passing to the New World, it will be proper to take a cursory survey of the remaining productions of Asia. The weeping willow grows wild in all parts of the temperate zone of this continent, from Persia to Japan. The plant whose root affords the medicinal rhubarb, is from the confines of Russian and Chinese Tartary. The crown imperial is from Persia. In the same country grows an umbelliferous plant, from whose root the stinking gum called asafœtida is procured. From India we have received the balsam and the kidney bean. There also grows the teak tree, or Indian oak, which has been much employed of late years in ship-building. It so far excels the European oak in durability, that Indian-built ships, constructed of the wood of this tree, often last forty years or more in those seas, where our ships are ruined in five years. Instead of corroding the iron bolts, the teak wood is said to possess an oily quality, which serves rather to preserve them. In India is also found the banyan-tree, whose branches have the remarkable property of drooping to the earth, and there taking root; so that a single tree forms a curiously-arched grove. From China we appear to have originally received the orange tree, which is now cultivated abundantly in Italy, Spain, Portugal, and other parts of the south of Europe. From the same country the hydrangea was introduced by Sir Joseph Banks, in 1790. It has been cultivated by the Chinese in their gardens from time immemorial; but of what place it is a native seems doubtful. The various species of China rose are of still more recent introduction into this country. The Chinese chrysanthemum, which produces its variously coloured and beautiful blossoms after almost all our other flowers are past, was introduced in 1795. From China we are also said to derive the radish and endive.

The tea tree is cultivated almost exclusively in China and Japan; and from the first of these countries our whole supply (amounting yearly to about three hundred and fifty thousand chests) is derived.

Before we travel further southward, to survey the vegetable productions of the torrid zone, it will be proper to cross the Atlantic, and take a

review of the plants belonging to North America; for so great is the resemblance between the tropical productions of the two hemispheres, and so little analogy have they with the productions of other parts of the globe, that it is better to contemplate them as a whole, rather than separately to speak of those which grow in the Old and in the New World. Returning therefore towards the polar regions, we shall find, on comparison, some interesting points of resemblance between the climate and vegetation of the corresponding shores of the two continents; the western coast of America exhibiting appearances similar to those of Norway and other countries on the western shore of Europe; while the vegetation of Newfoundland, on the eastern coast of America, is like that of Kamschatka, on the eastern coast of the Old Continent, in the same latitude. In Greenland, of which the southern extremity lies in latitude 59° 38′, (ten or eleven degrees nearer to the equator than the point at which trees cease to grow in Norway and Lapland,) are found only a few birches and willows, of which the utmost height is eighteen or twenty feet. At Nain, on the coast of Labrador, in latitude 57°, only one degree nearer to the pole than Edinburgh or Glasgow, the mean temperature of the year is 5° below the freezing point; lower, therefore, by 5°, than the mean temperature of Cape North, the extremity of Europe, in latitude 71°. In Canada, which lies under the same parallels of latitude with France, the rigour of the winters is destructive to every species of tree excepting those belonging to northern climates: yet the heat of the summers suffices to bring to perfection many of the southern annuals, and such low plants as are protected in winter by the covering of snow. In this country grows the Weymouth pine, not unfrequently planted in our shrubberies. It is a very beautiful tree when healthy and vigorous; and as it grows remarkably tall and straight, affords the best masts for large ships. Another native of Canada is the sugar maple, from whose sap a considerable quantity of sugar is annually prepared by the inhabitants.

The vegetable productions of the temperate regions of North America are distinguished by their variety and splendour, compared with those produced in the same latitudes of the eastern hemisphere. From the territories of the United States we have received some of the most beautiful of the family of bog-plants, magnolias, rhododendrons, azaleas, and kalmias. The magnolia grandiflora, whose northern limit, according to Humboldt, is in latitude 35½°, has been denominated the most admirable production of the vegetable world: it is an evergreen, bearing a leaf not unlike a laurel, but larger, with white flowers five or six inches in diameter, of delicious fragrance. From North America comes likewise the aloe, distinguished by its long, thick, fleshy leaves, furnished with thorns at the points and along the edges. It blooms only once, the plant dying after it has completed its fructification, as happens with our annuals and biennials; but, instead of coming to maturity in one or two years, it requires a very long period for its growth: according to the vulgar opinion, a hundred years; but this appears to be an exaggeration. When the time for its blooming arrives, a flower-stem rapidly pushes up from the root to the height of thirty feet or more, bearing a branched spike of many thousand large and splendid flowers. From the ridges of the Alleghany mountains, which intersect the United States, running nearly parallel with the shore of the Atlantic, comes the beautiful *robinia pseudo-acacia*, commonly cultivated in our shrubberies, under the name of acacia. Few trees equal it in elegance of foliage, or in the beauty of its pendent clusters of white pea-shaped blossoms, sometimes slightly tinged with pink. It grows very fast, and has been recommended by Cobbett to be planted for timber. In the United States is also found the red cedar, a tree not uncommon in our shrubberies. Its wood is employed for black-lead pencils, and for lining the inside of desks; for which last purpose it is recommended both by its pleasant smell and by its property of driving away insects. There also grows the tulip tree, the arbutus, and one of the two species of arbor vitæ commonly cultivated here: the other species, of a looser growth, which comes from China, is often improperly called the lignum vitæ. The sort of hard and heavy wood known by this name among cabinet-makers, is the produce of the guiacum, a tree growing in the West Indies, of totally different appearance.

The observations of Mr Barton of Philadelphia on the vegetation of the United States, furnish a remarkable proof how far maritime climates are from being universally milder than inland climates. Comparing the northern limits of the different species of plants on the western and the eastern side of the Alleghany Mountains, he ascertained that this limit extends, in most cases, several degrees further towards the pole in the interior than upon the coast. Thus, on the coast, the growth of the yellow horse chestnut terminates at latitude 36°; behind the mountains, at latitude 42°. The black walnut on the coast, ceases to grow in latitude 41°; behind the mountains, in latitude 44°.

It has been observed that in America the form of the continent, and disposition of the mountains, admit of a greater intermixture of the productions of warm and cold climates, than in the Old World; where the Mediterranean, extended from east to west, and the mountains, lying in the same direction, form impassable barriers, which preclude the passage of plants

from one latitude to another. Thus the pines of the north are found on the high lands of Mexico as far as the isthmus of Panama; and the liquid amber, a handsome tree, sometimes cultivated in our shrubberies, where it is valued for its fragrance, covers the declivities of the American mountains within the tropics, in latitudes 18—19°, and is found at the level of the sea, in latitude 43½°; while the native plants of Africa are, for the most part, quite distinct from those of Europe.

In the southern part of the United States are extensive plantations of tobacco, rice, and cotton. The tobacco plant, which is thought to be a native of the Andes, is seen not unfrequently in our gardens. The use of tobacco was introduced into England by Sir Walter Raleigh, in the reign of Elizabeth. Our best rice is from Carolina; but this grain is likewise imported from India, in which country, as well as in China, it forms a great part of the food of the inhabitants. The rice plant is said by Linnæus to be a native of Ethiopia. Cotton is procured from the pods of several plants, but all of them of one family: it forms the covering of the seeds. Those of the larger species, which attain to the magnitude of trees, require, according to Humboldt, a mean annual temperature of at least 68°: the shrubby kind is cultivated with success under a mean temperature of 60 to 64°, as far as latitude 40°. In the Old World this culture is carried on near Astracan, in latitude 46°.

The tree which furnishes us with mahogany, is a native of the New World. It grows to a large size, and produces handsome spikes of white flowers, not unlike those of the lilac. The mahogany of best quality comes from St Domingo; an inferior sort from Honduras, on the western shore of the Caribbean sea. From the same coast we receive two species of dye-wood: logwood, which yields a purple colour; and fustic, a brown. Brazil wood, which gives a red colour, is from Florida, on the other side of the gulf of Mexico. In the territories of the republic of Mexico grows the sun-flower, which in its native soil is said to attain to a height of twenty feet, with a flower two feet in diameter. The Jerusalem artichoke, nearly allied to the sun-flower, is from Brazil; the word Jerusalem being a corruption of the Italian *girasole*, "turn to the sun;" alluding to a property said to be possessed more or less by all the plants of this genus. From Mexico comes likewise the splendid dahlia, which was introduced into this country by lady Holland, in 1804. From Peru we have the potatoe, the *nasturtium*, the scarlet *fuchsia*, and the fragrant heliotrope. The common passion-flower is from Brazil.

The cactus family belongs as exclusively to the New World, as the heaths to the Old. As specimens of this extensive genus may be mentioned the prickly pear, or Indian fig, and the creeping cereus, which are common in our greenhouses. There is something very marked and extraordinary in the aspect of this tribe. In many of the species the functions of the leaves and the stems are so confounded, that it is difficult to say which of these parts is present, and which wanting. In the Indian fig it is the stem which seems wanting, the thick, fleshy leaves growing one out of the other: the foliage of the creeping cereus, on the other hand, consists entirely of long trailing stems like cat's tails. In most of the cacti, the plant is set with prickles disposed in bunches, which enter the flesh of a person handling them imprudently, and cause inflammation. The flowers are generally beautiful and brilliant; not produced on stalks, but issuing directly from the substance of the plant. A few of the cacti are found in the United States of North America; but most of them are natives of the West Indies and South America, where they attain to a great size, and contribute to the singular aspect of the vegetation of the tropical regions of the New World.

The last mentioned plants have brought us within the limits of the torrid zone. Let us now proceed to take a more general view of the productions of those glowing regions. These productions are not only more numerous, but more splendid in their colours, more fragrant, more pungent in their taste, and more varied in their forms than the plants of other climates. "When a traveller newly arrived from Europe, penetrates for the first time into the forests of South America, if he is strongly susceptible of the beauty of picturesque scenery, he can scarcely," says Humboldt, "define the various emotions which crowd upon his mind; he can scarcely distinguish what most excites his admiration,—the deep silence of these solitudes, the individual beauty and contrast of forms, or that vigour and freshness of vegetable life which characterises the climate of the tropics. It might be said that the earth, overloaded with plants, does not allow them space to unfold themselves." The trunks and branches of the trees are covered, not with mosses and lichens, as in our climate, but with beautiful flowers: among the rest with several species of *orchis*, a tribe of plants, some of which grow wild in our own country; remarkable for the singular resemblance of their flowers to certain species of insects. In the bee orchis, particularly, this resemblance is very striking. "In the torrid zone," continues Humboldt, "creeping plants often reach from the ground to the very summits of the trees, and pass from one to another at the height of more than a hundred feet, so as to deceive the observer, and lead him to confound the flowers, the fruit, and the leaves, which belong to different species. So thick and uninterrupted

are the forests which cover the plains of South America between the Orinoco and the Amazons, that were it not for intervening rivers, the monkeys, almost the only inhabitants of these regions, might pass along the tops of the trees for several hundred miles together without touching the earth." This vast wilderness presents none of that wearisome uniformity of aspect which often characterises the forests and heaths of temperate climates. Not only do we meet in the tropical regions with new *genera* and *species*, but with new *families* of plants, strongly contrasted in their forms and modes of growth with those of other parts of the world: others again acquire, in the torrid zone, the height and bulk of trees, which in Europe never exceed the magnitude of herbs; and some of those which abound in our climates wholly disappear.

Yet the mean annual temperature of the equatorial regions is by no means so different from that of other parts of the globe as we might be led to suppose by observing the extraordinary phenomena of tropical vegetation. In a climate where the bamboo attains in a few months to the height of sixty feet; where the whole aspect of the vegetable world exhibits so singular and striking an aspect, we naturally expect to find as marked an increase in the heat of the sun's rays. This, however, is not the case. There is no reason to believe that the mean temperature at the equator exceeds 82°, a degree of warmth by no means very uncommon in our own country. The mean temperature of Cumana, on the northern coast of South America, in latitude 10° 27′, is 82°; that of Havannah, the capital of the island of Cuba, in latitude 23° 10′, is 78°; that of Madras, in latitude 13° 5′, is 81°; that of Manilla, the principal of the Philippine islands, in latitude 15°, is 78°. In fact, the climate of most parts within the tropics is more remarkable for equability than for extreme heat. Twice in the year the sun is vertical to every place lying within the torrid zone; therefore every place so situated should have two summers in twelve months, and of course two winters. But, in fact, the difference of temperature at different seasons is so trifling in these regions, as scarcely to attract attention: at Cumana, for instance, the mean temperature of the winter is $80\frac{1}{4}$°; that of the three hottest months only $83\frac{1}{2}$°. The different seasons are marked by circumstances far more striking than this slight difference of temperature. From the time when the sun becomes vertical in its passage towards the tropic till it again becomes vertical in returning towards the equator, (that is, during the time answering to summer in the temperate zone,) the country, in most parts of the tropical regions, is deluged with almost continual rain, while the other part of the year is a season of fine weather.

A similar equability of climate is found to prevail in those districts which are situated far above the level of the sea, but of course accompanied by a lower temperature. Thus the mean temperature of Quito, directly under the equator, at a height of eight thousand feet, corresponds nearly with that of the south of France; but the lowest point which the thermometer has been observed to indicate at Quito is 42°; whereas at Marseilles, though the climate there is less liable to great fluctuations than in most places under the same latitude, the mercury sinks occasionally as low as 23°. The temperature of that great elevated plain which occupies the western side of the continent of South America, resembles a perpetual spring; and as very little difference is felt in the warmth of the different seasons, the gradual diminution of heat from the level of the sea upwards is more distinctly observable than in other climates. Accordingly, the several families of plants which cover the sides of the Andes are arranged in distinct belts or zones, whose limits are marked with a precision unknown in the mountains of Europe, where the plants belonging to the plains are sometimes seen growing in company with those of more elevated regions. Upon the declivities of the South American mountains may be found, within a comparatively small compass, every gradation of temperature, from that of the burning plains at their feet to the limits of perpetual snow; and every variety of vegetable productions, from the palms and bamboos, sugar-canes and plantains, to the mosses and lichens which clothe the rocks thirteen thousand feet above.

There are some families of plants which arrive in the tropical regions at a magnitude unknown in our climate, as the grasses, ferns, and mallows. The bamboo, which has a jointed hollow stalk like the grasses, often reaches the height of sixty feet. Of ferns we have in England about forty species, none of which exceed three or four feet in height; whereas in the torrid zone they attain the size of trees. Of all the forms of tropical vegetation, these and the bamboos, according to Humboldt, most excite the attention, and awaken the admiration of the traveller. In their general aspect the tree ferns resemble the palms. Their stems are generally black, as if burnt with the sun; their leaves of a bright and delicate green, beautifully crisped at the edge. It has been observed of the ferns that they principally delight in insular situations; few comparatively are found in the interior of large continents, owing, perhaps, to the want of a due proportion of moisture. They abound amongst the dropping springs that ooze from the crevices of rocks; and some species of exquisite beauty are found lining the sides and roof of the little caverns which contain the sources of

natural fountains. Ferns are very numerous in Jamaica, in New Zealand, in Otaheite, and in St Helena. In this last island they constitute a large proportion of the whole number of native plants.

Of the mallow family only five species exist in England, all of them very small; while in the torrid zone the plants of this family are exceedingly numerous and splendid, many of them attaining to the magnitude of our forest trees.

The species of palms hitherto discovered, exceed 130 in number. Not only do they excel every other family of plants in beauty and stateliness, but in the luxuriance of their fructification. Amidst the solitudes of the South American forests, in places far remote from human habitation, Humboldt found the ground covered with the fruit of these trees in places to the depth of three inches. More than 12,000 flowers have been counted in a single sheath of the date palm. The wax palm, which bears on its trunk a varnish of wax, is a native of the Andes. The cocoa nut grows abundantly in the South Sea islands; and the plantain or banana, is dispersed over large tracts of the tropics. The sugar cane, supposed to be a native of China, now grows over all the West India islands, as do also the coffee plant and indigo. The pine apple is conjectured to be a native of New Spain; but it appears to grow wild in Africa and other parts of the Old World. The caoutchouc, or Indian rubber tree, is a native of Brazil. That curious

76.

Rafflesia Arnoldii.

flower the *Rafflesia Arnoldii*, the blossom of which, when fully expanded, measures no less than three feet in diameter, and the petals three quarters of an inch in thickness, is a native of the island of Sumatra.

In India and the East India islands, grow the greater number of our spicery and aromatic plants, as cinnamon, cloves, camphor, ginger, pepper, nutmegs; as also the gums and resins used in medicine and perfumery.

Instead of the European grains, maize and rice are the chief products of tropical regions, and other farinaceous substances allied to corn, such as arrow root, sago.

The bread fruit tree, which bears a substance having the taste and much of the nutritive qualities of wheaten bread, is a native of the South Sea islands.

Humboldt has given a sketch of the vegetation of the Andes, commencing at the level of the ocean and extending to the highest summits. A condensed view of this sketch may serve as a general illustration of the distribution of plants as influenced by climate, arising from altitude above the sea level.

1. *Tropical Zone* or *Region of Palms.* This region stretches from the level of the ocean to the height of 513 toises. Here flourish the magnificent family of palms, odoriferous and balsamic plants, the family of *scitamineæ*, laurels, mimosa, the sugar cane, coffee plant, and indigo.

2. *Temperate Zone.* Above the region of palms is that of the tree-ferns and cinchonas, the latter of which yield the different kinds of Peruvian bark, the caoutchouc tree, camphor shrubs, passion flower, and a variety of beautiful and useful plants. At 1330 to 1340 toises is the region of oaks. Here also grow wheat, barley, and oats, and the fruit trees of Europe.

3. *Alpine Zone.* From 1026 to 2103 toises, extends the region of alpine plants. Here flourish the ranunculi, gentians, and a variety of hardy plants. At an elevation of 2103 the alpine plants give place to the gramineæ, of which the region extends to 2360 toises.

4. *Arctic Zone.* This region may be so called, for at the height of 2360 toises all flowering plants disappear, and lichens alone clothe the rocks and ground. Some of these, indeed, appear to vegetate under the snow, for at 2850 toises, near the summit of Chimborazo the *umbilicaria pustulata*, and *verrucaria geographica*, are seen growing on a shelf of rock; and these were the last organized substances adhering to the soil at so great a height, which Humboldt and his companions were able to detect.

5. *Snowy Region.* The last region is that within the line of perpetual congelation, whence eternal ice and snow hold their dominion.*

Mr H. Watson has portioned out the island of Great Britain into three regions, each of which are subdivided into two zones, thus:

I. Woody region,	1. Agricultural zone 2. Upland zone
II. Barren region,	3. Moorland zone 4. Subalpine zone
III. Mossy region,	5. Alpine zone 6. Snowy zone.

1. The woody region extends over at least three-fourths of the whole surface of Britain. In England all the south-eastern dictrict, and a very

* See illustrative diagram, Plate II. where the mountain on the right corresponds to this description.

large proportion of the others, belong to it. The summits of the Penine chain, the hills in the lake counties, and the high ranges in Wales being the exceptions.

From the wide surface which it occupies, the woody region necessarily presents much difference at its two extremes, particularly in the minor details; yet, on the whole, there is more of sameness in its general features than might be anticipated. From one end to the other it is an undulated plain of meadows, pastures, and cultivated fields, separated from each other by hedgerows of hawthorn or stone walls; and thickly interspersed with parks, woods, gardens, towns, and high roads, betokening a climate where man may attain a high state of civilization, and live for ease and pleasure as well as for laborious occupation. It is the region where flourish the trees and bloom the flowers rendered classic by our poets. It is the land of the daisy and cowslip, the oak and the hawthorn, the hazel copse, and the woodbine bower; the region of fruits and flowers.

The *Agricultural Zone* is distinguished from the upland by the presence of wheat fields, and indeed this grain may be reckoned the characteristic of the zone. The highest elevation at which wheat is cultivated in the north of England, does not exceed 1000 feet. In Scotland from 800 to 1000 feet. Here the fruits of Britain flourish in greatest perfection, as well as all our finest and most delicate garden produce.

The *Upland Zone.* In sheltered situations with a favourable aspect, the oak, beech, wild-cherry, ash, sycamore, and lime, still form fine timber trees; and the lilac, laburnum, monthly rose, and corchorus, flourish in the gardens. Apples, cherries, and currants, ripen; but the peach, plum, and apricot, will not do in the open air. The Scotch fir flourishes as well as the birch, rowan, and trembling poplar. In sheltered vallies, and by the borders of lakes, corn fields are found, and most of the common weeds and larger grasses.

2. *Barren region.* Black swamps and cheerless moors make up this region. The dwarf birch, bog myrtle, juniper, and the heaths, compose the principal part of the woody plants. The cloud berry is one of the few fruits. Its lower subdivision or moorland zone, still exhibits traces of some flowers and flowering shrubs, as the alpine arbutus, the broom, and furze, and the *digitalis*, or fox-glove.

The subalpine zone or upper division, assumes a still more barren aspect; stinted shrubs and heaths, mosses and lichens, being the sole vegetation.

3. The *Mossy region* is destitute of shrubs, and is characterised by the cryptogamic plants, a few weeds, grasses, and saxifrages. Its alpine zone gradually passes into the snow line, constituting the snowy zone, where all vegetation is repressed by perpetual congelation.*

CHAP. XXIII.

SYSTEMS OF BOTANICAL CLASSIFICATION.

When the sciences were as yet in their infancy, and when all that was known of them consisted of but a small number of facts, those who devoted themselves to their cultivation required but very little exertion, and a tolerable memory, to enable them to embrace the entire knowledge, and retain the names of the objects, in the study of which they were engaged. The first philosophers who treated of botany speak of plants without adopting any order or methodical arrangement. In the time of Theophrastus, who first wrote particularly on vegetables, the functions of the organs were misunderstood, the genera and species were entirely confounded, and their distinctive characters were unknown. For although that philosopher may be said to have been the first who wrote on botany, it may also be said that, in his time, the science had no real existence. The characters of plants rested merely on empirical knowledge, or on simple tradition; for their number was then so limited, that it was easy to know them all individually, without its being necessary to distinguish them otherwise than by imposing a particular name upon each, with which, however, no idea of character or comparison was connected. Such was the state of botany during many ages, when, from its intimate connection with medicine, it found a place only in the works of those who wrote on the healing art. But when, in consequence of more judicious inquiries, and of journeys made to distant countries, the number of objects belonging to natural history was increased, it became necessary to employ more precision in naming these different objects, and to distinguish them by characters of some kind, that they might be more easily recognised. In a short time, the memory was unable to retain the names of the numerous objects which accumulated, and which were mostly new, and previously unknown.

At this period, naturalists began to be sensible of the necessity of arranging objects in some order, which might facilitate research, by furnishing the means of arriving more readily, and with more certainty, at the names which had been given to them individually. But the arrangements followed were at first entirely em-

* In Plate II. the mountain on the left represents the British distribution of plants, numbered according to the above description.

pirical, and have no title to be regarded as true methods. Indeed, they were not at all founded on the knowledge derived from characters peculiar to these objects individually, and which might serve to distinguish them from each other, but rested merely upon some external circumstances, which were often foreign to the nature of the object. Thus the alphabetical order in which plants were arranged, could be of no advantage excepting to those who were already acquainted with them, and were desirous of examining some of them more particularly. This is equally the case with the arrangements founded upon the economical or medicinal properties of plants, which always suppose a previous knowledge of the virtues of the plants whose names it is proposed to discover.

It will easily be perceived that, upon such foundation, there could only be raised classifications of the most defective character, as they generally rested upon circumstances unconnected with the nature and organization of plants. They were, therefore, incapable of affording any satisfactory idea of them.

Experience, however, soon showed the necessity of deriving the characters by which plants might be made known and distinguished from their own organization, and the parts of which they are composed. From this period, botany assumed the rank of a science; for it was then that the organization of plants began to be studied, in order to educe from it the characters by which these objects might be made known and distinguished.

Methods now began to assume a regular form. But, as the organs of vegetables are numerous, the number of methods became correspondingly great, as each author imagined some one of the former to supply the most solid foundation for a good arrangement. Thus some of them founded their methods on the consideration of the roots, and of all the modifications which these organs are capable of presenting; others upon the stems; some like savages, on the leaves; others on the inflorescence.

In the sixteenth century, Gessner, a native of Zurich, first demonstrated that the characters derived from the flower and fruit are the most certain and the most important for obtaining from them a good classification of plants. He also showed the existence, among plants, of groups, composed of several species, connected by common characters. This first idea of grouping vegetables into genera, had the greatest influence upon the after progress of botany.

Soon after, Cæsalpinus, who was born in 1519, at Arezzo, in Tuscany, presented the first model of a botanical method. In it all the species were arranged according to the consideration of characters which may be derived from most of the organs of plants, such as their duration, the presence or absence of the flowers, the position of the seed, their adhesion to the calyx, and the number and situation of the cotyledons. The invention of such a method, imperfect as it is, must be considered as the first step towards the discovery of a natural classification.

The number of known vegetables, however, was daily receiving augmentation from new discoveries, and the works that existed were becoming more and more insufficient. Several authors, among whom may be mentioned with approbation the two brothers Bauhin, Ray, Magnol, and Rivinus, successively gave proofs of extraordinary merit in their works. Some of them even invented new methods, which, however, were all eclipsed by that of Joseph Pitton de Tournefort, which was published about the end of the seventeenth century.

That celebrated botanist, one of those whose writings have most redounded to the honour of his native country, was born at Aix, in Provence, on the 5th June 1656. He was professor of Botany at the Garden of Plants, in Paris, in the reign of Louis XIV., who, in 1700, sent him on an important mission to the Levant. Tournefort, at that time, traversed Greece, the shores of the Black sea, and the islands of the Archipelago. He returned to Paris, and published an account of his journey, which may be mentioned as one of the most perfect models of its kind. Previous to his departure, he had already promulgated, in a work entitled Institutions of Botany, his new method, in which were described 10,146 species, which were referred to 698 genera.

Tournefort's merit was not solely that of having invented an ingenious method, in which were described and arranged all the plants then known. His principal title to fame is his having been the first who distinguished, with more strictness and precision than had previously been done, the genera, the species, and the varieties which might be referred to them.

Before his time the science was a mass of confusion. The species were not clearly distinguished from those to which they were allied. He first reduced the chaos of botany to order, separated the genera and species by characteristic phrases or definitions, and, by means of his ingenious system, arranged all the plants then known in methodical array.

After Tournefort appeared a great number of botanists, who enjoyed a certain degree of reputation. Some of them proposed new methods, none of which, however, had the least tendency to eclipse that of Tournefort. This glory seemed reserved for the celebrated Linnæus, whose system, which was published in 1734, had the most surprising success, on account of its extreme simplicity, and the singular facility which it affords for attaining a knowledge of the names of plants.

Linnæus had moreover the merit of reforming, or rather of creating, the nomenclature and synonymy of botany, which his predecessors had left in so imperfect a state. Tournefort himself had traced the path to be pursued, without, however, clearing away all the obstacles. Hitherto each species was still named by a characteristic phrase, in which the distinctive characters were frequently not included. These phrases were so long that it was very difficult to retain any number of them in the mind. Linnæus gave a proper or generic name to each group or genus, in so far following the example of Tournefort. He further designated each species of these genera by a specific name added to the generic; and, by this ingenious contrivance, greatly simplified the already very extensive study of botany.

The sexual system of Linnæus, which was rendered so seductive by its extreme simplicity, produced a sudden revolution in the science, and was every where received with an enthusiasm which it would be difficult to describe.

When the first emotions of admiration which a great discovery always inspires, had somewhat subsided, it was soon perceived that this system, ingenious as it was, yet possessed some disadvantages, and was not entirely unobjectionable. Being founded upon the absolute consideration of a single organ, it often separated plants which all their other characters seemed to unite beyond the possibility of their ever being disjoined; for it had already been perceived that certain genera of plants possess so many points of contact and of mutual resemblance, and are so united by their general characters, that they seem, as it were, members of the same family. Thus the *gramineæ*, *labiatæ*, *umbelliferæ*, *leguminosæ*, *cruciferæ*, and several other groups equally natural, had already been brought together in the form of distinct tribes. The separation of plants which it might be considered so necessary to keep together, was therefore a great defect in the artificial system of Linnæus. Thus the gramineæ were dispersed in the first, second, third, sixth, twenty-first, and twenty-third classes of his system. The labiatæ were placed partly in the second class and partly in the fourteenth. Most of the natural tribes, which had already been admitted as such by a great number of botanists, were separated in the same manner, as Linnæus found himself obliged to adhere strictly to the principles of his system.

Another method, which, retaining the already acknowledged affinities of plants, might present their general distinctive characters, was, therefore, preferable to a system which, however ingenious, was faulty in one of the most important points.

Adanson gave the first sketch of such a method. Bernard de Jussieu searched, during forty years, for the most solid and constant characters on which to found it. He studied with the greatest care the natural affinity of the species and genera. But his nephew, Antoine Laurent de Jussieu, bringing together the rich materials collected by his uncles, and adding to them the numerous observations which he had made himself, was the real author of the method of natural families. It was in his *Genera Plantarum*, a work stamped with the impress of genius, and one of the finest monuments of the progress of botany, that he laid the foundations of a method, which must one day be the only one adopted and followed by all unprejudiced minds, it being unquestionably superior to any that has hitherto been published.

It has not as its basis the consideration of a single organ, but examines all the characters furnished by every part of a plant, and brings together all those which bear the greatest affinity and resemblance to each other. It is owing to this method that botany, within the last forty years, has made such rapid progress, and has assumed the first rank among the natural sciences.

It may be here observed, that there are two very distinct kinds of classification in natural history. In one, the consideration of a single organ is taken as the basis. Thus Tournefort employed the corolla, and Linnæus the stamina, for establishing their principal divisions. The name of systems has been given to these purely artificial arrangements. It will easily be conceived that a system, having no other object than that of enabling one to find out the name of a plant with facility, affords no idea of its organization. Thus, when we have found that a plant belongs to the first class of the system of Linnæus, or of that of Tournefort, all that we know is, that, in the former case, it has a single stamen, and that in the latter its corolla is monopetalous, regular, and bell-shaped; but these systems disclose to us nothing respecting the other parts which compose the plant, of which they have taught us only the name. In the second kind of classification, which has received the name of method, properly so called, as the basis of each class rests upon the total sum of all the characters derived from the different parts of the plant, when we come to one of these classes, we already know the more prominent points of the organization of the plant whose name we are desirous of knowing. Should we, for example, have found, by means of analysis, that the plant which we are examining belongs to the fourth class of Jussieu, this circumstance apprises us that it is a phanerogamous plant, that its embryo has only a single cotyledon, that it has only one floral envelope, and that its stamina are inserted upon the ovary.

We shall now proceed to explain the three most prominent and important systems of classification, that of Tournefort, Linnæus, and Jussieu.

Tournefort's System is founded chiefly upon the consideration of the various forms of the corolla. He is generally blamed for not having followed the example of Rivinus, and for continuing to separate herbaceous and woody plants. This system is very defective in this respect, as these two modifications of the stem frequently occur in the same genus, and circumstances may sometimes act so directly upon the same species, as to render it at one time woody and at another herbaceous.

This system consists of twenty-two classes, of which the characters are taken—1. From the consistence and size of the stem; 2. From the presence or absence of the corolla; 3. From the separation of the flowers, or their union within a common involucre, in which latter case they are compound; 4. From the circumstance of the corolla being entire or divided into separate segments; 5. From its regularity or irregularity.

1. With reference to the consistence and duration of their stem, Tournefort divides vegetables into herbs and suffruticose plants, shrubs, and trees. The herbs and suffruticose plants together are contained in the first seventeen classes. The last five classes contain the shrubs and trees.

2. Agreeably to the presence or absence of the corolla, herbs are distinguished into petalous and apetalous. The first fourteen classes of herbs contain all those which are furnished with a corolla, the other three those which are destitute of one.

3. The herbs which have a corolla have their flowers separated and distinct, or united to form compound flowers. The first eleven classes contain the herbs which have simple flowers, the three next those which present compound flowers.

4. Of the herbaceous plants with simple flowers, some have a monopetalous corolla, while in the others it is polypetalous. In the first four classes Tournefort has brought together the plants which have a monopetalous corolla, and in the next five those with a polypetalous one.

5. But this monopetalous or polypetalous corolla may be regular or irregular, and these circumstances have furnished subdivisions.

The plants which have a woody stem are contained in the last five classes of the system. Tournefort has divided them according to the same principles as in the herbaceous plants. Thus they are apetalous, or furnished with petals; their corolla is monopetalous or polypetalous, regular or irregular.

It is of importance to remark, that Tournefort gave the name of corolla to the single and coloured perianths, as in the tulip and lily, which, according to his ideas, have a regular polypetalous corolla.

Such are the principles by which Tournefort was guided in forming the classes of his system, of the characters of which we shall now give a brief view.

FIRST DIVISION.—HERBS.

WITH SIMPLE FLOWERS.

Corolla monopetalous, regular.

Class I. Campaniform.—Herbs with a regular monopetalous corolla, resembling a bell, as in the bellflower, convolvulus, the lily of the valley, the heath, &c.

Class II. Infundibuliform.—Herbs with a regular monopetalous corolla, resembling the form of a funnel, as in the tobacco; that of an ancient cup, as in the lilac, or that of a wheel, as in borage.

Corolla monopetalous, irregular.

Class III. Personate.—Corolla monopetalous, irregular, resembling in form a calf's mouth or an antique mask, as in the genus *antirrhinum*; or having the limb more or less open, as in the foxglove and figwort. Plants of this class always present a simple ovary in the bottom of their calyx.

Class IV. Labiate.—Corolla monopetalous, irregular, the limb as if divided into two lips:—plants having an ovary divided into four very distinct lobes, which are considered as naked seeds. Such are the sage, rosemary, betony, thyme.

Corolla polypetalous, regular.

Class V. Cruciform.—Corolla polypetalous, regular, composed of four petals, placed crosswise. The fruit is a siliqua or a silicula. Of this kind are the wallflower, cabbage, shepherd's-purse.

Class VI. Rosaceous.—Corolla polypetalous, regular, composed of from three to ten petals, arranged in the form of a rose, as in the pear tree, the apple tree, the wild rose, the strawberry, the rasp, the cistus.

Class VII. Umbelliferous.—Corolla polypetalous, regular, composed of five petals, which are often unequal; the flowers arranged in an umbel. Such are angelica, parsnip, fennel.

Class VIII. Caryophyllous.—Corolla polypetalous, regular, formed of five petals with long claws, contained in a monopetalous calyx; the limb expanded, as in the pink, soapwort, corncockle, and the *caryophylleæ* in general.

Class IX. Liliaceous.—Flowers with the corolla generally polypetalous, composed of six or only three petals, sometimes monopetalous, with six divisions. The fruit is a trilocular capsule or berry, as in the lily, the tulip, the hyacinth.

Corolla polypetalous, irregular.

Class X. Papilionaceous, or Leguminosæ.—

Corolla polypetalous, irregular, composed of five petals, an upper one named the standard, two lateral named the wings, two lower, sometimes united, forming the keel, as in the pea, the kidney bean, Lucerne. The fruit is always a legume.

Class XI. Anomalous.—This class contains all the herbaceous plants whose corolla is polypetalous, irregular, and not papilionaceous, such as the violet, nasturtium.

WITH COMPOUND FLOWERS.

Class XII. Flosculose.—Flowers composed of small, funnel-shaped, regular monopetalous corollas, having their limb divided into five segments. Each of these small flowers is named a floret. Of this kind are thistles, artichokes, knapweeds.

Class XIII. Semiflosculose.—Flowers composed of a great number of small, irregular monopetalous corollas, whose limb is thrown to one side, and to which the name of semiflorets has been given, as the lettuce, the goatsbeard, the dandelion.

Class XIV. Radiate.—Flowers composed of florets at the centre, and semiflorets at the circumference, as in the sunflower and the daisy.

APETALOUS PLANTS.

Class XV. Apetalous.—Plants whose flowers have no true corolla, as the grasses, barley, rice, the oat, wheat. In some there is around the sexual organs a simple perianth or calyx, which often remains after the flowering is over, and grows with the fruit, as in docks.

Class XVI. Apetalous, entirely destitute of flowers.—Plants which have no sexual organs or floral envelopes properly so called, but which have leaves. Of this kind are the ferns, such as polypody, osmunda.

Class XVII. Apetalous, without apparent flowers or fruit, as mushrooms, mosses, lichens.

SECOND DIVISION.—TREES.

Apetalous.

Class XVIII. Apetalous Trees or Shrubs, having their flowers destitute of corolla. These trees are either hermaphrodite or monœcious, as the box, many coniferæ, &c.; or diœcious, as in the genera *terebinthus*, and *lentiscus*.

Class XIX. Amentaceous.—Apetalous trees, whose flowers are disposed in catkins. They are monœcious, as the oak, the walnut; or diœcious, as the willows.

Monopetalous.

Class XX. Trees with a regular or irregular monopetalous corolla, such as the lilac, the elder, the catalpa, the arbutus.

Regular polypetalous.

Class XXI. Trees or shrubs with *rosaceous* polypetalous corolla, as the apple tree, the pear tree, the orange and cherry tree.

Irregular polypetalous.

Class XXII. Trees or shrubs whose corolla is *papilionaceous*, as in the acacia and laburnum.

Such are the twenty-two classes proposed by Tournefort for the arrangement of all known vegetables. Although, at first view, this system may appear simple and easily reducible to practice, it yet in many cases presents difficulties which are not easily overcome. Thus the form of the corolla is not always so decided as to enable one immediately to determine the class to which it really belongs; for where is the precise point of separation between a hypocrateriform and an infundibuliform corolla, or between the latter and a campanulate corolla?

The greatest objection that can be offered to this system is, that it separates the herbaceous from the woody plants. The most natural relations are by this means mistaken, and plants which bear the greatest resemblance to each other are often widely separated, on account of their differing in this respect only.

Each of these classes has been subdivided into a greater or less number of sections or orders, whose characters have been taken from particular modifications which the form of the corolla may undergo, from the consistence, composition, and origin of the fruit, the form, arrangement, and composition of the leaves.

Moreover, each of these sections contains a greater or less number of genera, to which are referred all the species that were known up to the period at which Tournefort wrote.

The sexual system of Linnæus is principally founded on the different characters which may be derived from the male organs or stamina, in the same manner as Tournefort's system is founded upon the various forms which the corolla presents. It consists of twenty-four classes.

Linnæus first divides all the known vegetables into two great sections. In the first he places all those which have sexual organs, and consequently distinct flowers. These are the phanerogamous or phænogamous plants. The second section comprehends those in which the sexual organs are not apparent, or in which they are entirely wanting. There are thus two primary sections in the vegetable kingdom:—

1. Phanerogamous plants.
2. Cryptogamous plants.

But, as the number of vegetables belonging to the first section is infinitely greater than that belonging to the second, the phanerogamous plants have been divided into twenty three classes,

whereas the cryptogamous form only the twenty-fourth and last class of this system.

Of the phanerogamous plants some have hermaphrodite flowers, that is, having the two sexes united, while the rest are unisexual.

The first twenty classes of the sexual system contain the phanerogamous plants, with hermaphrodite or monoclinous flowers. In the next three are placed the diclinous plants, or those with unisexual flowers.

3. Phanerogamous monoclinous plants.
.... diclinous plants.

The monoclinous plants have the stamina free and detached from the pistil; or the stamina are united to the pistil.

4. Monoclinous plants with free stamina.
.... with stamina united to the pistil.

The stamina, when disunited from the pistil, may be free and distinct from each other; or they may be united together.

5. Stamina not united to the pistil, free and distinct.

Stamina not united to the pistil, united together.

The free and distinct stamina are equal or unequal to each other.

Those which are free and equal exist in determinate or indeterminate number.

6. Stamina free and equal, in determinate number.

Stamina free and equal, in indeterminate number.

It was upon considerations of this kind that Linnæus laid the foundations of his system. Accordingly, it will be seen that it is founded:—

1*st*, Upon the number of stamina, *the first thirteen classes.*

2*dly*, Upon their relative proportion, *the fourteenth and fifteenth.*

3*dly*, Upon their connection by means of the filaments, *the sixteenth, seventeenth, and eighteenth.*

4*thly*, Upon their union by means of the anthers, *the nineteenth.*

5*thly*, Upon their union with the pistil, *the twentieth.*

6*thly*, Upon the separation of the sexes, *the twenty-first, twenty-second, and twenty-third.*

7*thly*, Upon the absence of sexual organs, *the twenty-fourth.*

1. *Stamina in determinate number, and equal to each other.*

Class I. Monandria.—It contains all the plants whose flowers have only a single stamen, as *Hippuris vulgaris, Blitum, Canna indica.*

Class II. Diandria.—Two stamina; the jasmine, the lilac, the genus *Veronica*, the sage, the rosemary.

Class III. Triandria.—Three stamina: most of the gramineæ, the genus *Iris.*

Class IV. Tetrandria—Four stamina: the madder, the bedstraw, the woodroof, the genus *Scabiosa.*

Class V. Pentandria.—Five stamina: the borragineæ, such as the borage and lungwort; the Solaneæ, such as the bitter-sweet, the belladonna, the potato, the winter-cherry; the exotic rubiaceæ, as the genera *Chinchona, Psychotria;* the Umbelliferæ, as the parsnip, the hemlock, the opoponax, the coriander.

Class VI. Hexandria.—Six stamina. To this class belong most of the Liliaceæ, the lily, the tulip, the hyacinth; many Asparagineæ, as the asparagus, the lily of the valley, and the rice.

Class VII. Heptandria.—Seven stamina. This is a very small class. It contains the horse-chestnut, the saururus.

Class VIII. Octandria.—Eight stamina: the genera *Rumex, Polygonum,* and *Erica.*

Class IX. Enneandria.—Nine stamina. To this class are referred the different species of *laurus* and *rheum, butomus umbellatus.*

Class X. Decandria.—Ten stamina. In this class we find nearly all the Caryophylleæ, such as the pink, the genera *Lychnis* and *Silene,* the rue, *Phytolacca decandra.*

2. *Stamina not strictly determinate as to number.*

Class XI. Dodecandria.—From eleven to twenty stamina. As in *asarum Europæum, reseda luteola, agrimonia eupatoria, sempervirum tectorum.*

Class XII. Icosandria.—More than twenty stamina inserted upon the calyx. To this class belong the true rosaceæ, the plum, the almond, the rose, the strawberry, the myrtle, the pomegranate.

Class XIII. Polyandria.—From twenty to a hundred stamina, inserted under the ovary. In this class are contained the true ranunculaceæ, such as *anemone, clematis, ranunculus, helleborus;* most of the papaveraceæ, such as the common poppy, chelidonium.

3. *Relative length of the Stamina.*

Class XIV. Didynamia.—Four stamina, of which two are always smaller and two longer, all inserted upon an irregular monopetalous corolla. This class contains the labiatæ and personatæ of Tournefort; such as thyme, lavender, the bugle, betony, snapdragon, foxglove, scrophularia, catalpa.

Class XV. Tetradynamia.—Six stamina, of which two are always smaller than the other four: the corolla polypetalous; the fruit a siliqua or silicula. This class corresponds entirely to the cruciferæ of Tournefort.

4. *Union of the Stamina by their filaments.*

Class XVI. Monadelphia.—Stamina in variable number, united into a single body by their

filaments; as in the mallow and marsh-mallow.

CLASS XVII. DIADELPHIA.—Stamina varying in number, united by their filaments into two distinct bodies. Of this kind are the fumitory, the milkwort, and most of the leguminosæ, as the acacia, laburnum, liquorice, melilot.

CLASS XVIII. POLYADELPHIA.—Stamina united by their filaments into three or more bundles. As in the genera *Hypericum*, *Cistus*, *Melaleuca*.

5. *Union of the Stamina by the anthers.*

CLASS. XIX. SYNGENESIA.—Five stamina united by the anthers: flowers generally compound, rarely simple. This class contains the flosculosæ, semiflosculosæ, and radiatæ of Tournefort. It also contains certain other plants, such as the genera *Lobelia*, *Viola*.

6. *Union of the Pistil and Stamina.*

CLASS XX. GYNANDRIA.—Stamina united into one body with the pistil. To this class belong all the orchideæ, the genus *Aristolochia*.

7. *Flowers unisexual.*

CLASS XXI. MONŒCIA.—Male flowers and female flowers distinct, but both occurring on the same individual. As in the oak, the box, the maize, the arrow-head, the castor-oil plant.

CLASS XXII. DIŒCIA.—Male flowers and female flowers existing on two separate individuals of the same species, as in *mercurialis*, the date-palm, the misseltoe, willows, the pistacia.

CLASS. XXIII. POLYGAMIA.—Hermaphrodite flowers, male flowers and female flowers occurring together on the same individual, or on different plants, as in the ash, the pellitory, the crosswort.

8. *Flowers invisible.*

CLASS XXIV. CRYPTOGAMIA.—Plants whose flowers are invisible, or very indistinct. This class contains the ferns, such as the polypody, osmunda; mosses, lichens, equiseta, algæ, fungi.

We have now given a brief account of the characters of each of the twenty-four classes established by Linnæus in the vegetable kingdom. It will be seen that the arrangement of this system is simple, and easily understood. Indeed, one might at first think that he had nothing more to do than to count the number of stamina in a flower, to know the class to which it belongs; but, in many cases, this determination is not so easy as might at first be supposed, and one is very often left in doubt, especially when the plant presents some unusual anomaly.

THE ORDERS. In the first thirteen classes, the characters of which are taken from the number of the stamina, those of the orders have been obtained from the number of styles or distinct stigmas. Thus a plant belonging to the class Pentandria, such as the parsnip or any other umbelliferous plant, which may have two styles or two distinct stigmas, is referred to the second order. Should it have three, it will belong to the third order, &c. These orders are designated as follows:—

Order 1. *Monogynia*, one style.
Order 2. *Digynia* , two styles.
Order 3. *Trigynia*, three styles.
Order 4. *Tetragynia*, four styles.
Order 5. *Pentagynia*, five styles.
Order 6. *Hexagynia*, six styles.
Order 7. *Heptagynia*, seven styles.
Order 8. *Decagynia*, ten styles.
Order 9. *Polygynia*, numerous styles.

It is to be remarked, that there are classes in which this entire series of orders does not occur. In *Monandria*, for example, there are only two orders: *Monogynia*, to which belongs the genus *Hippuris*; and *Digynia*, which contains the genus *Blitum*.

In *Tetrandria*, there are three orders: *Monogynia*, *Digynia*, and *Tetragynia*. There are six in *Pentandria*, and in the classes following a variable number.

In the fourteenth class, *Didynamia*, Linnæus has founded the characters of the two orders into which he divides it, upon the structure of the ovary. The fruit is sometimes formed of four small akenia, situated at the bottom of the calyx, and which he considered as four naked seeds. Sometimes, on the other hand, it is a capsule, which contains a variable number of seeds. The first order bears the name of *Gymnospermia* (naked seeds,) and contains all the true labiatæ, such as the genera *Marrubium*, *Phlomis*, *Nepeta*, *Scutelaria*. The second order, which is named *Angiospermia* (enclosed seeds,) and of which a capsular fruit is characteristic, contains all the Personatæ of Tournefort, such as the genera *Rhinanthus*, *Linaria*, *Melampyrum*, *Orobanche*.

Tetradynamia, the fifteenth class, has also two orders, derived from the form of the fruit, which is a siliqua or a silicula. Accordingly, we have first *tetradynamia siliculosa*, containing the plants of which the fruit is a silicula, such as the genera *Isatis*, *Cochlearia*, *Thlaspi*, &c.; and secondly, *tetradynamia siliquosa*, containing those of which the fruit is a siliqua; as the wall-flower, cabbage, the water-cress.

The sixteenth, seventeenth, and eighteenth classes *Monadelphia*, *Diadelphia*, and *Polyadelphia*, have been established on the union of the staminal filaments into one, two, or more distinct bundles, without regard to the number of stamina of which these bundles consist. Linnæus has, in this case, employed the characters derived from the number of the stamina to form the orders of these three classes. Thus the plants

which belong to *Monadelphia*, are said to be triandrous, tetrandrous, pentandrous, or polyandrous, according as they contain three, four, five, ten, or a greater number of stamina united by their filaments into a single body. In *Diadelphia* and *Polyadelphia*, the same method is followed, the orders having the names of the first classes of the system.

Syngenesia, the nineteenth class of the sexual system, is one of the most extensive. In fact, the synantheræ or syngenesian plants form about the twelfth part of all the known vegetables. It was therefore necessary to divide this class into several orders, to facilitate the investigation of its different species. Linnæus, accordingly, instituted six orders. But here the number of the stamina could not be employed as the basis of these subdivisions, it being almost invariably five; for which reason he derived the characters of the orders from the structure of the little flowers which constitute the assemblages known by the name of compound flowers; for in consequence of constant abortions, there occur along with the hermaphrodite flowers, male flowers, female flowers, and even sometimes perfectly neutral flowers. Linnæus, whose poetical fancy is observable in all the names which he imposed upon the different classes and orders of his system, looked upon these associations and mixtures of flowers as a kind of *polygamy*. This name he accordingly gave to each of the six orders of syngenesia, adding to it a distinctive epithet. The following are their characters.

Order 1. *Polygamia æqualis*. All the flowers are hermaphrodite, and in consequence are all equally fertile; as in thistles and goatsbeards.

Order 1. *Polygamia superflua*. The flowers of the disk are hermaphrodite, those of the circumference female; but both kinds furnish perfect seeds, as in wormwood and tansy.

Order 3. *Polygamia frustranea*. The flowers of the disk are hermaphrodite and fertile, those of the circumference neutral or female, but sterile in consequence of their stigma, and therefore entirely useless; whereas in the preceding order they were only superfluous, as the knapweeds and sunflowers.

Order 4. *Polygamia necessaria*. The flowers of the disk are hermaphrodite, but sterile, in consequence of an imperfect formation of the stigma; those of the circumference are female, and fecundated by the pollen of the former. In this case, they are therefore necessary for the preservation of the species: the marigold is an example.

Order 5. *Polygamia segregata*. All the flowers are hermaphrodite, and placed close together, but are separately contained each in a small involucre of its own, as in the genus *Echinops*.

Order 6. *Polygamia monogamia*. The flowers are all hermaphrodite, but they are simple, and are separated from each other, as in the violet, lobelia, balsamine.

The last order, as may easily be seen, has no affinity to the rest, possessing nothing in common with them but the union of the stamina by their anthers.

In *Gynandria*, the twenty-first class of the sexual system, there are four orders which are derived from the number of the stamina. Thus we have *Gynandria monandria*, as in the genera *Orchis* and *Ophrys; Gynandria diandria*, as in *Cypripedium; Gynandria hexandria*, as in *Aristolochia; Gyandria polyandria*, as in *Arum*.

Monœcia and *Diœcia* present in some measure a union of all the modifications which we have remarked in the other classes. Thus *Monœcia* contains monandrous, triandrous, decandrous, polyandrous, monadelphous, and gynandrous plants. Each of these varieties is used for the establishment of a distinct order in this class.

Diœcia contains a still greater number of varieties, the characters of which being the same as those of some of the classes previously established, are employed as designative of the orders.

The twenty-third class, *Polygamia*, which contains plants with hermaphrodite flowers and unisexual flowers intermingled, whether on the same individual, or on two or three distinct individuals, has, in accordance with these circumstances, been divided into three orders.

1. *Monœcia*, in which the same individual bears monoclinous flowers, and declinous flowers; 2. *Diœcia*, in which there are hermaphrodite flowers on one individual and unisexual flowers on the other; 3. *Triœcia*, in which the species is composed of three individuals, one bearing hermaphrodite flowers, another male flowers, and the third female flowers.

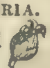
Cryptogamia, the twenty-fourth and last class, is divided into four orders: 1. Ferns; 2. Mosses; 3. Algæ; 4. Fungi.

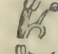
TABLE OF CLASSIFICATION.

CLASSES. ORDERS.

1. MONANDRIA.

Plants of one stamen and one or two pistils.



1 Monogynia 

2 Digynia 

2. DIANDRIA.

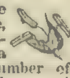
The British plants in this class have two stamens and one or two pistils the flowers are larger and their parts more distinct than in the first class.

1 Monogynia 

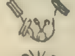
2 Digynia 

3. TRIANDRIA.

Plants of three stamens, and one, two, or three pistils. Besides a considerable number of very beautiful plants, and a few useful in medicine, this class contains the most important natural family in the whole circle of vegetation—the Graminea.



1 Monogynia 

2 Digynia 

3 Trigynia 

4. TETRANDRIA.

The plants in this class are distinguished from those in Didynamia by their four stamens being of equal lengths, and by their flowers being of distinctly different natural orders.

1 Monogynia
2 Digynia
3 Trigynia

5. PENTANDRIA.

Plants of five stamens not united. This class is distinguished from Syngenesia by its flowers being simple, while those of Syngenesia are compound.

1 Monogynia
2 Digynia
3 Trigynia
4 Tetragynia
5 Pentagynia
6 Hexagynia
7 Polygynia

6. HEXANDRIA.

In this class the flowers have six stamens all nearly of the same length, and one to four pistils; but none of the genera have four petals like those we find in Tetradynamia.

1 Monogynia
2 Digynia
3 Trigynia
4 Polygynia

7. HEPTANDRIA.

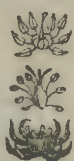
Plants of seven stamens. There is only one British genus in this class.

1 Monogynia

8. OCTANDRIA.

The British plants of this class have eight stamens, and one, three, or four pistils. Some of the Ericas are much admired for their beauty, and the Daphne is an active alterative medicine.

1 Monogynia
2 Trigynia
3 Tetragynia



9. ENNEANDRIA.

Plants of nine stamens. This class contains only one British indigenous plant.

1 Hexagynia

10. DECANDRIA.

The British plants in this class have ten stamens and one, two, three, or five pistils.

1 Monogynia
2 Digynia
3 Trigynia
4 Pentagynia

11. DODECANDRIA.

Plants from eleven to nineteen stamens, and one, two, three, or twelve pistils.

1 Monogynia
2 Digynia
3 Trigynia
4 Dodecagynia

12. ICOSANDRIA.

This class consists of hermaphrodite plants, with twenty or more stamens fixed in the calyx. They produce our most esteemed fruits; and no poisonous fruit has yet been found where the parts of the flower correspond with the characters of this class.

1 Monogynia
2 Pentagynia
3 Polygynia

13. POLYANDRIA.

The plants belonging to this class are hermaphrodite, and have twenty or more stamens fixed in the receptacle. The situation or insertion of the stamens constitutes the essential and characteristic distinction between the twelfth and thirteenth classes.

1 Monogynia
2 Pentagynia
3 Polygynia

14. DIDYNAMIA.

This class consists of plants with four stamens, two longer than the other two, and one pistil. The orders are formed upon the presence or absence of a covering to the seeds. The flowers in the first order are all ringent; in the second order they are most frequently personate, or resupinate.

1 Gymnospermia
2 Angiospermia

15. TETRADYNAMIA.

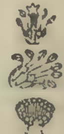
Plants of six stamens, four long and two short, and one pistil, which turns into a two-valved pericarp, called a Siliqua; some of these pericarps are long, and retain the name siliqua; others are short, round, or flat, and receive the name of silicle, and upon this distinction of their seed-pods the orders are formed.

1 Siliculosa
2 Siliquosa

16. MONADELPHIA.

The plants in this class have the filaments of their stamens united into one set.

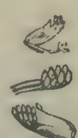
1 Pentandria
2 Decandria
3 Polyandria



17. DIADELPHIA.

The plants in this class have their stamens in two sets, of which the first genus is an excellent example; but there are five of the genera strictly Monadelphous in the union of their stamens, and the other genera have one stamen separate from the rest on the upper surface of the pistil.

1 Hexandria
2 Octandria
3 Decandria



18. POLYADELPHIA.

The plants of this class are hermaphrodite, and their stamens are united into three or more sets. There is but one British genus.

1 Polyandria

19. SYNGENESIA.

This class is composed of compound flowers, consisting of many little florets within one common calyx. When these are hermaphrodite, they have five stamens united by their anthers into a cylinder, round one pistil. Some of the florets are tubular, others ligulate, some hermaphrodite, some female, and others neuter. Our British genera are embraced by Dr Smith in three orders; viz. 1st. those where the little florets are all hermaphrodite, ex. thistle; 2d. those where the florets in the disk are hermaphrodite, and those in the ray, female, ex. mountain daisy; the 3d. where the florets in the disk are hermaphrodite, and those in the circumference neuter, ex. blue bottle.

1 Polygamia Æqualis


2 Polygamia Superflua


3 Polygamia Frustranea


20. GYANDRIA.

The plants of this class bear flowers, with stamens situated on the style, or upon a receptacle stretched out in form of a style, which supports both stamens and pistils.

1 Monandria


2 Diandria


3 Hexandria


21. MONŒCIA.

The Monœcious or one-house plants, have their stamens in one flower, and their pistils on a separate flower on the same plant—the orders are from the number and connection of the stamens. Besides a number of herbaceous plants, some of the most beautiful and useful of our forest trees belong to this class.

1 Monandria

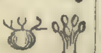

2 Triandria


3 Tetrandria


4 Pentandria


5 Hexandria


6 Polyandria


7 Monadelphia


22. DIŒCIA.

The Diœcious, or two-house plants, are male and female, the stamens are found in the flowers of one plant, and the pistils in the flowers of another—the orders are from the number and connection of the stamens. Some soft-wooded, quick growing plants belong to this class, as the willow and the poplar.

1 Diandria


2 Triandria


3 Tetrandia


4 Pentandria


5 Hexandria


6 Octandria


7 Enneandria


8 Monadelphia


23. POLYGAMIA.

The plants of this class have hermaphrodite, and male or female flowers, or both on the same plant. Dr Hull, in his British Flora, has arranged and described seven genera in this class.

1 Monœcia


24. CRYPTOGAMIA.

The cryptogameous plants are those vegetables whose parts of fructification are so minute that they are but imperfectly visible to the naked eye. Linnæus divided the plants of this class into 4 natural orders, viz. Filices, Musci, Algæ, and Fungi.

1st Order. Filices.—The Filices, or Ferns, in general push up only one stem, termed a frond, which, in the early stage of its growth, is rolled up in a spiral form. They bear their fructification in a spike, in a racemus, or on the under surface of the leaf. The Botrychium is an example of a spike, the Osmunda of a racemus, and the Polypodium bears its fructification on the under surface of the leaf. The fructification is arranged in lines or dots; and from their situation and direction, with the presence and manner of opening of a thin covering termed the Involucre, and from being with or without an elastic ring, the genera are formed and distinguished.

2d Order. Musci.—The mosses are a beautiful natural family of very minute plants, whose female parts of fructification are covered by a calyptra, which adheres to the top of the theca, and in general opens transversely. The mouth of the theca is sometimes naked, and sometimes clothed with a single or double fringe, termed a periostoma. Its divisions are named teeth; and from their number, their being upright or reflected, straight or twisted, triangular, spear, or bristle-shaped, blunt or acute, and whether their seeds are smooth or rough, angular or round, the genera are characterized.

3d Order. Algæ.—The plants in this order have their root, stem, and leaf, of one continuous similar piece of matter. They are divided into those which grow on the land and those that grow in the water. Their generic characters are taken from their parts of fructification when these are any way evident, and from the general structure of the plant when these organs escape notice.

4th Order. Fungi.—The fungi consists of plants mostly of a spongy or cork-like texture. They are generally of short duration, and bear their seeds in gills or tubes, or attached to fibrous or spongy substances. Their generic characters are taken from the disposition of their seeds, or from their external figure or appearance.

1 Filices


2 Musci


3 Algæ


4 Fungi


We have now stated the principles of the sexual system, and presented a sketch of its twenty-four classes and numerous orders, such as they were established by Linnæus. In examining this system, one is struck by its extreme simplicity, and the ease with which the name of a plant may be discovered by means of it. The classes, in fact, are, for the most part, precisely limited and defined, especially those which have the stamina in determinate number. Not only does this system contain all the plants already known, but it is also capable of comprehending all that may yet be discovered. In consequence of its possessing these advantages, it was generally adopted at the period of its first publication.

But it must be admitted, that it labours under more than one serious disadvantage. It is not always easy to determine the precise class to which a plant ought to be referred. Thus the rue (*Ruta graveolens*) has almost all its flowers furnished with eight stamina, there being only a single flower in the centre of each of its groups that presents ten. The beginner, in this case, would experience some embarrassment, and might be induced to place the plant in question in the eighth class of the system, *Octandria*, although Linnæus referred it to *Decandria*, as he considered the flower with ten stamens as the most perfect.

Dodecandria, in like manner, is not very strictly characterized. It contains all the plants which have from twelve to twenty stamina; but the agrimony, which is referred to it, has often more than twenty.

Certain labiatæ or personatæ which belong to *Didynamia*, have their four stamina of equal length, and the irregularity of the corolla is, in many cases, hardly perceptible.

It is extremely difficult to determine with certainty the orders to which many plants belonging to *Syngenesia* should be referred. Besides, the intermixture of male flowers, female flowers, and hermaphrodite flowers, throws several of them into *Diœcia* and *Polygamia*. The sixth of these orders *Polygamia Monogamia*, contains plants which have no affinity to the compositæ, such as the genera *Viola*, *Lobelia*, *Impatiens*.

Polygamia, the twenty-third class, is a confused mixture of plants, which almost all belong to some of the other classes.

If we now examine the plants brought together under each of these classes, we find that very frequently the natural affinities that have long been established are entirely disregarded. Thus one of the most natural families, the Gramineæ, is scattered through the classes *Monandria*, *Diandria*, *Triandria*, *Hexandria*, *Monœcia*, *Diœcia*, and *Polygamia*. The labiatæ are partly placed in *Diandria*, partly in *Didynamia*. It is the same with many other families equally natural. But as the classification proposed by Linnæus is a *system*, that is, a methodical, but purely artificial arrangement, intended solely for facilitating the discovery of the name of a plant which one may be desirous of knowing, it would not be just to blame it for having thus separated plants which bear a great resemblance and affinity to each other. But the Linnæan system is not the one which is to be studied when the object is to obtain a knowledge of the mutual relations of plants, although, of all the artificial systems, it is unquestionably that which enables one to find the name of a plant with most ease.

The system of Jussieu, or The method of Natural Families, differs essentially in its course and characters from the systems of Tourneforte and Linnæus, which we have already explained. In it the divisions are not founded upon the consideration of a single organ, but are derived from characters presented by all the parts of plants. Accordingly, the plants which are thus brought together are disposed in such a manner that they have a greater affinity to that which immediately precedes or follows them than to any other.

This classification is therefore superior to those which preceded it, in so far as it presents general and philosophical ideas respecting the productions of the vegetable kingdom. It does not consider objects separately, but collects and arranges them into groups or families, according to the greatest number of common characters which they possess.

We find that nature, in impressing upon the external form of certain plants a peculiar character bearing relation to their internal organization, seems to have indicated to a certain extent, the affinities which exist among vegetable productions. In fact, there are many plants which bear so great a resemblance to each other in the structure and conformation of their parts, that this similarity has at all times been perceived, and these different plants have been considered as in some measure belonging to the same family.

Thus the Gramineæ, Labiatæ, Cruciferæ, and Synanthereæ, have always been kept together whenever the characters of affinity and mutual resemblance have not been sacrificed to the principles of an artificial system.

Accordingly, when botanists began to bring together plants into families, that is, into groups or series of genera, resembling each other in the greater number of characters, they had only to imitate nature, which had, as it were, created types of essentially natural families, as if to serve as models. Thus the leguminosæ, cruciferæ, gramineæ, umbelliferæ, labiatæ, &c., stood forth to the view as so many examples which were to be imitated.

But as all plants have not, like those just

named, external characters so precise or so decided as at once to disclose their resemblance to certain others, recourse was had to analysis, and it became necessary to search in all their organs for modifications which might furnish characters.

The characters have to be considered with reference to their value, their number, and their affinity.

With respect to their value, it will easily be conceived that the characters derived from the most essential organs of plants must be less liable to variation, and more important than those derived from other organs. Now, those organs which conduce to reproduction, perform the most important part in vegetable life, and among them the embryo, which is in a manner the common end towards which all the organs of the plant direct themselves, is that which occupies the first rank in importance. The embryo, therefore, has supplied Jussieu with his primary divisions. The stamina and the pistil occupy the second rank, and afford more constant and more valuable characters than the floral envelopes. These characters are the more fixed and important, that they are derived, not from the number and structure of these organs, which are very subject to variation, but from their relative position, which is fixed. Thus, next to the embryo, the relative position of the sexual organs, or their *insertion*, affords the best characters for the arrangement of plants. Lastly, the stems, the leaves, and the roots, are all employed as accessory characters.

With respect to their number, the characters are associated, grouped, and arranged; and, from the combination of simple characters, result general characters, which serve to unite a certain number of plants under a common denomination.

Some characters are mutually connected, and seem inseparable from each other. Those which are derived from the flower and fruit are chiefly of this kind. Thus for example, the inferior ovary always implies a monosepalous calyx and an epigynous insertion. A monopetalous corolla almost always indicates that the stamina are inserted upon it, and that they have a determinate number.

From the value and importance which the different characters possess, it is easy to see that those least liable to vary ought to have been employed for the fundamental divisions of the vegetable kingdom. Thus the embryo has furnished the first three great divisions in plants. The stamina and the floral envelopes have afterwards been employed for subdividing the first three sections, which were established upon the embryo.

Jussieu's method is thus explained by Richard: The plants that occur scattered over the surface of the globe constitute the individuals of the vegetable kingdom. When we examine them with attention, we soon perceive that in the general mass there are numerous individuals, which always present themselves to our view under the same appearance, possess the same external and internal characters, and are always reproduced under the same form. To all these perfectly similar individuals, considered generally and abstractly, the name of *species* is given. The species, then, is the aggregate of individuals which are always reproduced in the same manner. A seed produced by any given species always gives rise to an individual perfectly similar to that from which it originated. The characters on which the distinction of the different species from each other is founded, are generally derived from the organs of vegetation, that is, from the leaves, the stem, and the roots. The species which present some differences with respect to the colour of their flowers, the place in which they grow, and their relative height, constitute *varieties*, which are distinguished from species properly so called, by the circumstance of their not being, in the *natural* state, reproduced from seeds with all their characters. Thus, for example, the lilac usually has the flowers of a delicate purple tint; but its flowers are sometimes white, although none of the other characters have been altered. The white lilac, then, is merely a variety of the purple lilac; for if seeds taken from the white-flowered lilac are sown, they give rise to individuals whose flowers are indifferently purple or white; which proves that varieties are not always preserved by means of seed.

The *genus* consists of a greater or less number of species, united by common characters derived from the organs of fructification, but all distinguished from each other by *specific* characters peculiar to each of them, and furnished by the organs of vegetation. Thus, the genus *Anagallis* has for its characters a rotate monopetalous corolla, five stamina, and a *pyxidium* for its fruit, that is, a globular capsule opening in a circular manner by a kind of lid. All the species of this genus must possess these different characters; but they are distinguished from each other by the form of their stem and leaves. The other genera are similarly constituted.

If we bring together the genera in the same manner as the species; in other words, if we place near each other all those which have common and similar characters, we form *orders* properly so called, if regard is had only to a single character, such as the number of the stigmas, the form of the fruit, &c.; and *natural families* or *orders*, if we include all the considerations that relate to the form, the structure, and the relative disposition of all the organs of the plants which we are arranging.

By a *natural order* or *family* of plants must therefore be meant a series or assemblage of genera, which all present the same characters in the organs of fructification.

Thus the family of cruciferæ is characterized by a dicotyledonous embryo, a siliquose or siliculose fruit, usually four petals opposed to each other in pairs, stamina in determinate number, &c. All the genera of that family must present the same characters, but only with some slight modifications, which do not alter the primitive type, but afford distinctive characters for the genera which collectively constitute the family in question.

By following a course like this, botanists have brought together the various species of plants, so as to form them into groups or natural families. But as these families are numerous, it was necessary to distribute them into classes, in which regard should be had to the same resemblance and affinity. It is to this classification of the families that the name of *Jussieu's Method*, or the system of natural families, has been given. This system has been divided into fifteen classes. The primary divisions are derived from the characters which may be obtained from the presence or absence of the embryo; whence the *embryonate* and *inembryonate* plants.

The embryonate plants are distinguished according to the number of their cotyledons: 1st, Into monocotyledonous; 2dly, Into dicotyledonous. All vegetables are arranged under these three primary divisions: *acotyledones, monocotyledones, dicotyledones.*

The second consideration, or that by which the classes properly so called are established, is founded upon the relative insertion of the stamina, or of the staminiferous monopetalous corolla. Now, we have seen that there are three kinds of insertion:

1. The *hypogynous insertion*, or that in which the ovary being entirely free, the stamina or the staminiferous corolla are inserted close around its base.

2. The *perigynous insertion*, or that in which the ovary being free or parietal, the stamina or the staminiferous monopetalous corolla are inserted into the calyx at a certain distance from the circumference of the base of the ovary.

3. The *epigynous insertion*, or that in which the ovary is always inferior, and in which the stamina or the staminiferous corolla are inserted upon the upper part of the ovary.

These three kinds of insertion serve to establish an equal number of classes.

The acotyledones being destitute of embryos, and consequently of flowers and fruits, could not be brought under this division, but constitute the first class.

The monocotyledones, possessing these three modes of insertion, have been divided into three classes: 1. Monocotyledones, with hypogynous stamina; 2. Monocotyledones, with perigynous stamina; 3. Monocotyledones, with epigynous stamina.

The acotyledones and monocotyledones, therefore, form four classes, thus:

Acotyledones,	. . . . .	Class I.
Monocotyledones,	stamina hypogynous,	Class II.
	stamina perigynous,	Class III.
	stamina epigynous,	Class IV.

The dicotyledones being much more numerous than the acotyledones and monocotyledones together, it was necessary to increase the number of their divisions. Here the insertion, although still attended to, becomes a secondary character. Thus it has been observed, that these plants are destitute of a corolla or are apetalous, or that they have a staminiferous monopetalous corolla, or that their corolla is polypetalous. These distinctions have given rise to the three first divisions that have been established among the dicotyledones, namely:

1. Apetalous dicotyledones.
2. Monopetalous dicotyledones.
3. Polypetalous dicotyledones.

The insertion has been employed as a secondary character for subdividing these three sections into classes. Thus the apetalæ form three classes, in which the insertion is epigynous, perigynous, and hypogynous.

The monopetalæ, of which the corolla always bears the stamina, in like manner form three classes, according as their staminiferous corolla is hypogynous, perigynous, or epigynous. The last, or epigynous class of the monopetalæ, has been further subdivided, according as the stamina are free or connected by their anthers, which carries the number of classes in the monopetalous corollas to four, namely:

Monopetalæ,	stamina hypogynous,	. .	Class I.
	stamina perigynous,	. .	Class II.
	stamina epigynous	anthers united,	Class III.
		anthers free.	Class IV.

These four classes, together with the three classes of the apetalous dicotyledones, and the four classes of the monocotyledones and acotyledones, form eleven.

The polypetalæ have, in like manner, been divided into three classes, according to their mode of insertion, which is epigynous, perigynous, or hypogynous.

Lastly, in the fifteenth or last class, are placed all the dicotyledonous plants, whose flowers are essentially unisexual, and separated upon distinct individuals. They have been named irregular diclinous plants.

Such are the fifteen classes which M. Jussieu established in the vegetable kingdom, for the purpose of methodically arranging the different

families of plants, which he had previously formed.

Each of these classes contains a greater or less number of natural families, all connected by the common character which constitutes the class. The number of these families is not definitively settled, and indeed cannot be so, as new discoveries, and more accurate observations, by making known new objects, or demonstrating the differences which exist between plants previously associated and confounded, continually augment the number of families. When M. de Jussieu published his *Genera Plantarum*, in 1789, he described 100 families. We have now upwards of 160, and the number is still capable of being increased.

We have thus exhibited a view of the three great systems of botanical arrangement, and in such detail as will enable the student of botany to perceive the relative merits of each. Undoubtedly the Linnæan system is best suited for a catalogue or dictionary, by which the species and families of plants may be recognised and classified; and for this purpose the system of Linnæus must be familiar to the botanist, and will ever hold its ground as an admirable contrivance to facilitate his progress. In the following pages, however, which are intended to convey to the general reader a popular view of the vegetable kingdom, more especially the practical and economical history of plants, the natural method or system of Jussieu will be adhered to, in so far as he has portioned out the vegetable kingdom into three great divisions, commencing with plants of the simplest structure, especially as regards their fructification, and ascending to those of a more complicated nature. But although we adopt this arrangement so far, we shall deviate in some measure in the subdivisions, and not follow exactly the order of the families instituted by Jussieu; on the contrary, we shall rather arrange the plants of each division as they furnish food, clothing, or other conveniences, to man, keeping as close, however, to the arrangement of natural families of plants as is consistent with our plan.

CHAP. XXIV.

FIRST DIVISION OF PLANTS, INCLUDING THE ALGÆ, FUNGI, LICHENS, MOSSES, AND FERNS.

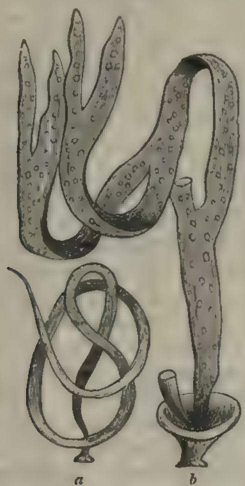
The First Division of the vegetable kingdom, including the *acotyledones*, or those plants destitute of a seed lobe, corresponds to the class *cryptogamia* of Linnæus. It contains all those plants which are destitute of true organs of generation, and which are reproduced by means of small sporules, in their structure and development more resembling the bulbs of some of the true flowering plants than that of ordinary seeds. Linnæus called those plants cryptogamia, because he imagined their fecundation to be effected by means of organs which were concealed or little known. De Candolle, remarking that only one vegetable structure entered into their composition, names them *cellular* plants, in opposition to the term *vascular*, which he gives to flowering plants.

The plants of this division nave a simpler structure than that of the phanerogamous or flowering plants. Many of them have not the distinction of root, stem, branches, and leaves, but consist simply of one mass of a uniform shape and texture throughout. The division contains the families of *algæ*, or sea weeds, *fungi*, or mushrooms, *lichens*, *mosses*, and *ferns*.

Algæ. Little interest, comparatively, has been taken in the algæ, because they have been found less conducive, either as articles of use or beauty, to the convenience of man. They are not, however, without their admirers; nor is the investigation of their form and structure devoid of that interest which all the works of nature are calculated to excite. We find, says Dr Greville, the vegetation of the ocean no less conspicuous for beauty and variety of form than splendour of colour, admirably fitted for the place it is designed to occupy, and of direct utility to mankind. Viewing these tribes in the most careless way, as a system of subaqueous vegetation, or even in a merely picturesque light, we see the depths of ocean shadowed with submarine groves, often of vast extent, intermixed with meadows as it were of the most lively hues, while the trunks of the larger species, like the giant trees of the tropics, are loaded with innumerable minute kinds as fine as silk, and delicate as the most transparent membrane. Nor must we forget that while thousands and tens of thousands of quadrupeds, birds, and insects, depend upon the vegetation immediately surrounding us for their very existence, a countless host of creatures derive protection and nourishment from the plants of the deep, appropriated to their use by that merciful Power in whom they live, move, and have their being, whose goodness is over all his works. Some of the algæ, placed, on account of the simplicity of their structure, at the bottom of the scale, are so small as to be invisible to the naked eye, except by the appearance they give to other species on which they happen to be parasitic in prodigious numbers. From these microscopic forms, algæ are found of all sizes on our shores, up to thirty or forty feet in length, an extent to which a common sea weed, like a rope or cord *(chorda filum)* not unfrequently attains. This plant resembles an enormous piece of catgut, and is in fact known by the name of sea catgut in Orkney, while in Shetland it goes

by the name of *Lucky Minny's lines*, and in England of *sea lace*, see cut, fig. *a*. Lightfoot mentions

77.



a. Sea Catgut, *chorda filum*; *b*. Himanthalia Lorea.

that the fronds, skinned when half dry and twisted, acquire so considerable a degree of strength and toughness, that the highlanders sometimes use them for fishing lines. In Scalpa bay, near Kirkwall in Orkney, says Dr Neill, we have sailed through meadows of it in a pinnace not without some difficulty, where the water was between three and four fathoms deep, and where of course the waving weeds must at least have been from twenty to thirty feet long. The various species of *sea tangle*, as *laminaria digitata* and *bulbosa*, are more robust, the former having a stalk as thick and as long as a stout walking stick, and a large flat many-cleft frond at the summit. It is a social species, grows erect in the water, and reminds the spectator of a palm-like tropical forest. The *L. bulbosa* has sometimes so large a head that a single plant is as much as a man can carry. It is in the southern hemisphere, however, that we must look for the most wonderful examples of marine vegetation. The *lessonia fuscescens*, described by Borey de St Vincent, is twenty-five or thirty feet high, and has a trunk often as thick as a man's thigh, which divides into numerous branches, each terminated by a lanceolated frond. The *laminaria buccinalis* of the Cape of Good Hope is much larger than our common tangle, and is furnished with a hollow stem, which the natives convert into a kind of horn, whence it has acquired the name of trumpet weed. The *fucus gigantæus* of Solander, or kelp, as it grows on the shores of Terra del Fuego, is thus described by Mr Darwin: "This plant grows on every rock from low water to a great depth, both on the outer coast and within the channel. I believe, during the voyages of the Adventurer and Beagle, not one rock near the surface was discovered which was not buoyed up by this floating weed. The good service it thus affords to vessels navigating near this stormy land is evident, and it certainly has saved many a one from being wrecked. I know few things more surprising than to see this plant growing and flourishing amidst those great breakers of the western ocean, which no mass of rock, let it be ever so hard, can long resist. The stem is round, shining, and smooth, and seldom has a diameter of so much as an inch. A few taken together are sufficiently strong to support the weight of the large loose stones to which, in the inland channels, they grow attached; and some of these stones are so heavy, that when drawn to the surface they can scarcely be lifted into a boat by one person." Captain Cook, in his second voyage, says, that at Kirguelen land some of this weed is of a most enormous length, though the stem is not much thicker than a man's thumb. I have mentioned that on some of the shoals upon which it grows we did not strike ground with a line of twenty-four fathoms. The depth of water, therefore, must have been greater; and as this weed does not grow in a perpendicular direction, but makes a very acute angle with the bottom, and much of it afterwards spreads many fathoms on the surface of the sea, I am well warranted to say, that some of it grows to the length of sixty fathoms and upwards. Certainly, at the Falkland islands, and about Terra del Fuego, extensive beds frequently spring up from ten and fifteen fathom water. I do not suppose the stem of any other plant attains so great a length as 360 feet, as thus stated by Captain Cook. Its geographical range is very considerable. It is found from the extreme southern islets, near Cape Horn, as far north on the eastern coast as latitude 43°, and on the western it was tolerably abundant, but far from luxuriant at Chiloe in latitude 42°; thus having a range of 15° of latitude. The number of living creatures of all orders whose existence intimately depends on the kelp is wonderful. I can only compare these great aquatic forests of the southern hemisphere with the terrestrial ones in the intertropical regions. Yet if the latter should be destroyed in any country, I do not believe nearly so many species of animals would perish as under similar circumstances would happen with the kelp. Independent of the numerous zoophytes, amidst the leaves of this plant many species of fish live which no where else would find food or shelter. With their destruction the many cormorants, divers, and other fishing birds, the otters, seals, and porpoises, would soon perish also; and lastly, the Fuegian savage, the miserable lord of this miserable land, would redouble his cannibal feast, decrease in numbers, and perhaps cease to exist.

The longest, perhaps of all known algæ, though at the same time comparatively slender, are the *macrocystes*. This appears to be the sea weed reported by navigators to be from 500 to 1500 feet in length. The leaves are long and narrow, and at the base of each is placed a vesicle filled with air, without which it would be impossible for the plant to support its enormous length in the water, the stem being not thicker than the finger, and the upper branches as slender as pack thread. All those algæ destined to resist the force and agitation of stormy seas, have roots peculiarly adapted to take the firmest hold of the rocks, which they grapple by means of tough and thick fibres. Other species of shorter duration, or presenting less surface to be acted on by the waves, are generally fixed by a simple shield-like base or disk.

Man, who has been humorously defined to be a cooking animal, not content with the tribute of fish rendered to him by the ocean, converts many of her vegetable productions into articles of diet. The *dulse* of the Scotch *(rhodomenia palmata)*, *dillesh* of the Irish, and *saccharine fucus* of the Icelanders, is consumed in considerable quantities throughout the maritime countries of the north of Europe, and in the Grecian Archipelago. Another species, nearly similar, the *iridœa edulis*, is still occasionally used both in Scotland and England. The thin purple and green membranous *slake*, or *laver (porphyra laciniata)*, is stewed, and brought to our tables as a luxury. The *pepper dulse (laurentia pinnatifida)*, distinguished for its pungent taste, and the young stalks of the sea tangle, were of old often eaten in Scotland; and even yet, though rarely, the old cry, "Buy dulse and tangle," may be heard in the streets of Edinburgh. When stripped of the thin part, the beautiful tangle, called in Scotland *badderlocks (alaria esculenta)*, forms a part of the simple fare of the poorer classes of Ireland and Scotland, Iceland, Denmark, and the Faroe islands. The *Irish moss*, as it is erroneously called, the *chondrus crispus*, very common on the Scottish and Irish coast, may, by boiling, be converted into a tenacious glue, or, boiled with milk and sugar, and allowed to cool, it forms a light and nutritious *blanc-mange*.

To go farther from home, we find the large sea tangle, *laminaria potatorum*, of Australia furnishing the aborigines with a proportion of their instruments, vessels, and food, while other species of the same family constitute an equally important resource to the poor on the west coast of South America. In Asia several species of *geledium* are made use of to render more palatable the hot and biting condiments of the East. Some undetermined species of this family also furnish the materials of which the celebrated edible swallows' nests are composed. It is remarked by Lamouroux, that three species of swallows construct edible nests, two of which build at a distance from the sea coast, and use the sea weed only as a cement for other matters. The nests of the third are consequently most esteemed, and they sell for nearly their weight in gold. *Gracelaria achenoides* is highly valued for food in Ceylon and other parts of the coast, and bears a great resemblance to *gracelaria compressa*, a species recently discovered on the British coast, and which seems to be little inferior to it.

It is not to man alone that these marine vegetables have furnished luxuries or resources in times of scarcity. Several species are greedily sought after by cattle, especially in the north of Europe. One species, *rhodomenia palmata*, is so great a favourite with sheep and goats, that Bishop Gunner named it *fucus ovinus*. In some of the Scottish islands horses, cattle, and sheep, feed principally on bladder fucus during the winter months; and in Gothland it is commonly given to pigs: other common species constitute a part of the fodder upon which the cattle are supported in Norway.

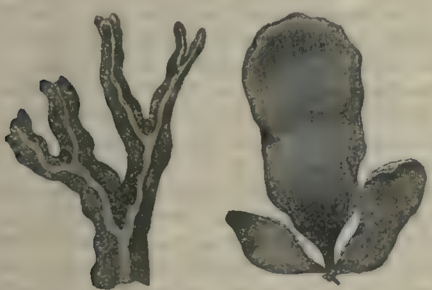
The algæ are also of service in medicine. The Corsican moss, as it is frequently called, is a native of the Mediterranean, and was at one time esteemed as a vermifuge. The most important medical use, however, derived from sea weeds, is their affording iodine, which may be obtained either from the plants directly, or after they have been converted into kelp. French kelp, according to Sir H. Davy, yields more iodine than British; and from some recent experiments made at the Cape of Good Hope, *laminaria buccinalis* is found to contain more than any European algæ. Iodine is known to be a powerful remedy in glandular swellings of a scrofulous nature, as also in cases of *goitre*, or swelling of the glands of the neck. The burnt sponge formerly administered in similar cases, most probably owed its efficacy to the iodine it contained; and it is also a very curious fact, that the stems of a sea weed are sold in the shops and chewed by the inhabitants of South America wherever goitre is prevalent, for the purpose of cure. This remedy is termed by them *polo coto*, literally *goitre stick*.

The algæ are also of essential service in the arts, and probably farther experience will daily render them more so. A Chinese sea weed, the *fucus tenax*, is extensively used by that people as a glue and varnish. Though a small plant, the quantity annually imported at Canton from the provinces of Fokien and Tchekiang is stated by Mr Turner to be about 27,000 lbs. It is sold at Canton for 6d. or 8d. per lb.; and is used for all those purposes for which we apply glue and gum Arabic. The Chinese employ it chiefly in the manufacture of lanthrons, to strengthen or varnish the paper; and sometime to thicken or

give a gloss to gauze or silk. It seems probable also that this is the principal ingredient in the celebrated gummy matter called chin-chou, or hai-tsai, in China and Japan. Windows made merely of slips of bamboo crossed diagonally, have frequently thin lozen-shaped interstices, wholly filled with this transparent gluten.

But it is in the manufacture of kelp, for the use of the glass maker and soap boiler, that the algæ take their place among the most useful vegetables. Almost all the common sea weeds may be used for the manufacture of this substance; but the most valued for this purpose are the fuci, generally known under the name of bladder kelp. The *fucus vesiculosus, nodosus,* and *serratus.*

78.



a. Fucus vesiculosus; b. Laminaria.

The different kinds of sea tangle are the *laminaria digitata*, and *bulbosa, himanthalia lorea,* and *chorda filum.*

The manufacture of kelp is an exceedingly simple process. The sea weed is cut from the rocks, and allowed to dry partially by spreading it on the beach. It is then taken to a simple kiln formed by a hole dug a few feet in the sand, and surrounded with rude stones, and ignited; as the dry sea weed gradually consumes, more is added, until the bottom of the kiln is filled with the ashes or kelp, which is a dark brown fursed-like substance of a half glassy aspect, consisting of soda mixed with many impurities. This manufacture was introduced into Scotland and its islands nearly half a century after it had been established in France and England. The first cargo exported from Orkney was in the year 1722. The employment, however, being new to the inhabitants, the country people opposed it with the utmost vehemence. Their forefathers had never thought of making kelp, and it would appear that they themselves had no wish to render their posterity wiser in this matter. So unanimous and violent was the resistance, that officers of justice were found necessary to protect the individuals employed in the work; and several trials were the consequence of those outrages. It was gravely pleaded in a court of law, on the part of the defendants, that the suffocating smoke that issued from the kelp kilns would sicken or kill every species of fish on the coast, or drive them into the ocean far beyond the reach of the fishermen; blast the corn and grass on their farms; introduce diseases of various kinds; and smite with barrenness their sheep, horses, and cattle, and even their own families,—a striking instance of the gross prejudice, indolence, and superstition of the simple people of Orkney in those days. The influential individuals who had commenced the manufacture, succeeded at last in establishing it; and the benefits which accrued to the community soon wrought a change in the public feeling. The value of estates possessing a sea coast well stocked with sea weed, rose so much in value, that where the plants did not grow naturally, attempts were made, and not without success, to cultivate them by covering the sandy bays with large stones. By this method a crop of sea weed has been obtained in about three years, the sea appearing to abound every where with the necessary seeds. During the years 1790 to 1800, the annual quantity sometimes made was 3000 tons; and as the price was then from £9 to £10 per ton, the manufacture brought into the place nearly £30,000 Sterling in one season. During the eighty years subsequent to its introduction, the total value amounted to £595,000 Sterling. Thus in the space of eighty years the proprietors of those islands, whose land rent did not exceed £8000 a year, had, together with their tenants and servants, received in addition to their incomes the enormous sum of more than half a million. In the Hebrides also, kelp is extensively manufactured. "The inhabitants of Canna," says Dr E. D. Clarke in 1797, ' like those of the neighbouring islands, are chiefly occupied in the manufacture of kelp; cattle and kelp constitute, in fact, the chief objects of commerce with them. The first toast usually given on all festive occasions is a high price to kelp and cattle. In this every islander is interested, and it is always drank with evident symptoms of sincerity. The discovery of manufacturing kelp has affected a great change among the people, whether for their advantage or not, is a question not yet decided. I was informed in Canna that, if kelps keep its present price, Macdonald of Clanronald will make £6,000 Sterling, and Lord Macdonald no less than £10,000."

During the course of the late war kelp rose to £18, £20, and even £22 per ton, in consequence of the interruption to the importation of barilla, and the profits upon it during that period were enormous. The price has subsequently fallen by degrees to £5 per ton, and the sale has latterly been heavy even at that rate. This was to be attributed at first to the superior qualities of the Spanish *barilla*, for the purposes of glass making and soap boiling; but more recently to the almost entire removal of

the duty on muriate of soda or common salt. The rock salt of Cheshire, which now bears an insignificant price, is submitted to a chemical process, by means of which the soda is separated from the muriatic acid; and this is found to answer so completely as a substitute for kelp, that the great glass manufacturers of Newcastle are supplied with soda thus prepared. So pernicious, however, are the fumes of the muriatic acid gas which issue from the soda works, that vegetation is destroyed to a considerable distance; and the proprietors have been compelled to purchase the ground in the immediate neighbourhood.

The number of people that find occupation in the manufacture of kelp is so great, that a permanent interruption to the trade would be a serious evil. In the Orkney islands alone, the number of hands employed a few years ago amounted to probably 20,000; for all the rural population is more or less employed in the business during the kelp season. Such being the case, it is gratifying to find that the Highland society have instituted inquiries regarding the qualities of kelp as a manure. It has long been known that common sea ware is extremely valuable for that purpose; and if the success which has attended the experiments already made with kelp, be confirmed by additional observation, the manufacture may still be regarded as an important article of domestic commerce.

It appears from communications made to the highland society, that the past success has been such as to induce Lord Dundas to take a cargo of fifty tons of kelp to Yorkshire, for the sole purpose of agricultural experiments. It has been tried as a top dressing, and singly, or in combination with other manures, on corn, pasture, potatoes, turnips, &c., and in most instances with decided good effect. The committee appointed to collect the result of the experiments, are inclined to think that, for raising green crops it would be better to compost it with other substances; that with good earth or moss, and a little vegetable or animal manure, a few tons of kelp would enable a farmer to extend his farm dung over at least four times the usual quantity of land. A very curious circumstance is mentioned by Mr M'Intosh, who tried the effects of kelp manure on potatoes, at Crossbasket near Glasgow. A severe frost which occurred in September injured and blackened every lot of potatoes to which the kelp had not been applied, while the kelp lots remained in perfect foliage, even when the respective drills were contiguous. It would appear that the soil for the time being had acquired a property equivalent to a certain degree of atmospheric temperature; or rather that the nourishment absorbed by the plants under such circumstances, had enabled them to resist a degree of cold that would otherwise have destroyed them.

The algæ grow very rapidly, and the produce is far less exposed to casualities than the crops of the agriculturist in so precarious a climate as that of the Hebrides and Orkney islands. While in some places the sea weed is cut only every third year, in others, especially where there are strong currents, an annual harvest may be obtained without injury. The rapidity of growth in the larger algæ, is indeed wonderful. When Mr Stevenson the engineer was erecting a lighthouse on the Carr rock, in the Firth of Forth, which rock is about sixty feet long and twenty broad, and only uncovered at low water, he had occasion to remark the quick renewal of the sea tangle with which it was covered. In the course of the autumn of 1813 the workmen had succeeded in clearing out and levelling with the pick and axe a considerable part of the foundation of the intended beacon, when, in the beginning of November, the operations were necessarily abandoned for the winter. At this time the rock was reduced to a bare state; the coating of sea weed had at first been cut away by the workmen; the roots or bases were afterwards trampled by their feet; and much of the surface of the rock had been chiselled. Upon returning to the Carr, in May 1814, in order to recommence operations, it was matter of no slight surprise to find the surface again as completely invested with large sea weeds as ever it was; although little more than six months had elapsed since the work had been left off, when, as already said, the rock had been cleared of weeds. In particular, it was observed that many new produced specimens of *fucus esculentus* measured six feet in length, and were already furnished with the small appendages near the base or pinnæ, which, at maturity, contain the seeds of the plants. The common tangle was generally only about two feet long. It may be observed that the specimens here alluded to, were taken from that part of the surface of the work which had been dressed off with the pick and chisel the preceding autumn; they had therefore grown from the seed.

Every zone of the earth presents a peculiar system of existence; and it is said that after a space of 24° of latitude, a nearly total change is observed in the species of organized beings, and that this change is chiefly owing to the influence of the sun. Lamouroux remarks, that if this holds good, as is certainly the case in phœnogamous plants, temperature should also exert some corresponding influence upon marine vegetation. It is beyond doubt that the algæ are found upon the British coasts in greatest abundance during the summer months, and in unusual luxuriance during hot seasons. It is probable also, the same author observes, that these plants may be acted on by the temperature of the water at greater or less depths; and that those

species which grow at the bottom of the ocean, may have some resemblance to those of the polar circle. On the shores of the British islands, it is easy to perceive that certain species become more plentiful and luxuriant as we travel from north to south; and on the other hand, that several others occur more frequently, and in a finer state, as we approach the north; while others again possess too extended a range to be influenced by any change of temperature between the northern boundary of Scotland and the south-western point of England. The researches and observations of Lamouroux have demonstrated satisfactorily that the great groups of algæ do affect particular temperatures or zones of latitude, though some genera may be termed cosmopolite. Thus the genus *codium*, a small greenish coloured and branched algæ, and the family Ulvaceæ, which consist of extremely thin, transparent, and purplish membranes, are scattered over every part of the world. *Codium tomentosum* is found in the Atlantic, from the shores of England and Scotland to the Cape of Good Hope in the Pacific; from Nootka Sound to the southern coast of New Holland. It abounds in the Mediterranean, on the shores of France, Spain, and Africa, and is common in the Adriatic; more recently it has also been brought from the coasts of Chili and Peru. This plant, however, is not a social one, to make use of a term that Humboldt has applied to some phœnogamous plants. It grows even in the same locality, in a solitary and scattered manner. The *ulvaceæ*, on the contrary, are strictly social, and preserve this character in every part of the world. They appear, however, to attain the greatest perfection in the polar and temperate zones. That they are capable of sustaining very intense cold, is proved by the fact that five specimens of them were picked up in high latitudes of the Arctic ocean, by some of the gentlemen in Captain Parry's voyages. The *Fucoideæ*, comprehending the sea tangles, increase as we leave the polar zone, especially in the variety of species. But the natural groups into which they are separated, are strongly marked in their distribution. The *fuci* flourish between the latitudes 55° and 44°; and according to Lamouroux, are rarely seen nearer to the equator than 36°. In New Holland, remarkable alike for its vegetable and animal productions, a distinct group of *cystoseiræ* predominates, as remarkable in the water as the aphyllous *acaciæ* are on land. Their stems are compressed, often appearing jointed: the branches spring from the flat side and not from the angles. The Red sea is full of another family, *sargassa*, of which several species, consisting of small branched and dark olive green plants, are common on our British shores. It is principally to one or two species of this family that the popular name of *gulf weed* is applied by mariners. The prodigious accumulations of these plants were first encountered by the early Portuguese navigators. Columbus compares them to extensive inundated meadows, and states, that they absolutely retarded the progress of his vessels, and threw the sailors into consternation. Such accumulations occur on each side of the equator, in the Atlantic, Pacific, and Indian oceans; but the sea particularly denominated *Mer do Sargasso*, by the Portuguese, stretches between the 18th and 22d parallels of north latitude, and the 25th and 40th meridians of west longitude. Humboldt describes the two banks of sea weed that occur in the great basin of the northern Atlantic ocean. "The most extensive is a little west of the meridian of Fayal, one of the Azores, between latitude 25° and 36°. Vessels returning to Europe, either from Monte Video or the Cape of Good Hope, cross the bank nearly at an equal distance from the Antilles and Canaries. The other occupies a much smaller space, between 22° and 26°, eighty leagues west of the meridian of the Bahama islands. It is generally traversed by vessels on the passage from the Caicos to the Bermudas." That these plants are produced within the tropics, there can hardly be a question; but at what depth they vegetate is still involved in obscurity. Neither is it clearly ascertained why the banks of weed should always occur in the same places. The supposition that they proceed with the gulf stream, from the gulf of Mexico, whence the name of *gulf weed*, is now exploded. It is evident that the gulf stream would convey them rather to the banks of Newfoundland than to the latitudes in which they usually occur; and it could not, in any case, accumulate them to the south of the Azores.

Some of the algæ prefer the southern sides of rocks; others affect an eastern, western, or northern exposure; but they change their position according to the difference of latitude, those which are found on the southern side, in cold climates, being generally seen on the northern in the warmer and temperate regions. Certain species live near the surface, and close to the sea beach; others at various degrees of depth. The first would seem to enjoy the regular exposure to light and heat which they experience during the turnings of the tide: the second, on the contrary, show the influence of the atmosphere; and growing and fructifying in depths where the light can scarcely ever penetrate, they bear, without receiving any injury, both the enormous column of water which constantly presses upon them, and the severe cold which exists in those regions. There are even parasitical algæ which grow indifferently upon all the others, and some which only affect peculiar species. Many sea weeds prefer such spots as are exposed to the fury of the waves, and the action of the current,

where they are perpetually floating in an agitated medium; others dwell in the hollows of rock, or in the marine gulfs, where the water is generally calm. The lapse of a few days puts a period to the existence of some kinds, while the tempests of successive winters fail to destroy others. The general aspect is apt to change in several individuals, so that were it not for more stable characters derivable from their fructification and texture, they might be mistaken for new species. A number of the more delicate marine plants are quickly destroyed by a removal from their native place of growth; but the greater proportion being coriaceous, and insoluble in salt water, live for a length of time in different situations; and it is not uncommon to find upon our own shores the algæ of the most distant regions which have traversed the ocean, and yet remain unchanged in their general appearance. From these circumstances it bears a necessary inference, that it is not all the algæ that are found in any country which may be said to belong to that country.

But there are few kinds of sea weed that prefer any particular spot, or show a predilection of one substance over another whereon to fix. Deriving no nutriment from the roots or points of attachment, they need nothing farther than a temporary support. Thus they cling indiscriminately to any solid marine body, equally to granitic and calcareous rocks, to floating or sunken pieces of wood, to the bones of terrestrial or marine animals, to shells or polypi. Notwithstanding that very highly respectable naturalists have averred that the growth of these plants proceeds with most vigour on such and such substances, on some or other peculiar rock in the vicinity of rivers, or in the open sea, it has been fully ascertained, says Dr Hooker, by a great number of observations, that marine weeds do grow with equal vigour, though planted upon rocks or substances of very different natures; and that, if we except some few *ulvæ*, which affect brackish water, those which vegetate in situations where fresh water mingles with the salt, are generally bleached, produce little or no fructification, have a thin and weak texture, and contain but little soda. The qualities requisite for their different uses are only found united in such sea weeds as grow in pure salt water, where they have found a spot which is sufficiently tenaceous to fix them in that zone of habitation which they prefer. Some kinds certainly prefer sand or mud; but then their roots become elongated and strike deep, till they meet with some stone or shell, or other body, which may serve them as a point of attachment, and offer the requisite degree of resistance.

If the nature of the bottom appears indifferent in a great measure, to marine plants, it is not so with the level which they select in the ocean, or with the distance of their birth place from the surface. Every species of maritime vegetables appears to make choice to as great an extent as the terrestrial kinds of certain zones or regions of different depths in the sea; places where the superincumbent weight of water, and the relative proportions of light and heat, are adapted to its peculiar organs. Those individuals which are found towards the centre of their proper zone, contain all the elements requisite for their perfect development, and generally show an active state of vegetation: they are vigorous; they fructify at the season suitable to their degree of immersion; while those that grow at the extreme limit, or out of the bounds of this same zone, prove languishing, fructify imperfectly, are always covered with marine animals, which destroy them, and live but a short time in comparison with their better situated congeners. The seeds which escape from these plants would appear by their various specific weights to gain an equilibrium equivalent to the column of water which they displace; or, in other words, to float in that peculiar zone which the future algæ would prefer to inhabit. Those which become developed either above or below it, are inevitably driven from their spot of nature or of election, by the agitation in the waves at the vicinity of the coasts.

Lower down than 100 feet from the surface of the sea, taking a medium between the high and the low tides, it is rare to find living sea weeds in the gulf of Gascony, and even these are attached to portions of rock severed from more elevated rocks, and before long they inevitably perish. It may be observed that the deeper we explore the waters of the ocean, the fewer will the number of plants appear; and the more numerous the *polypi*, or plant-like animals. Thus, below the depth of forty feet very few *ulvæ* are found; beyond sixty feet no living *cermium*, and after having descended to the depth of 100 feet, not a *fucus* is to be seen, and vegetable objects entirely disappear.

The *laminariæ*, among which are the giants of the marine flora, exhibit, in a general view, a tolerably decided geographical distribution. This family predominates from the 40th° to the 65th° of latitude; while another family, the *macrocystes*, seem to extend from the equator to about the 45th° of south latitude.

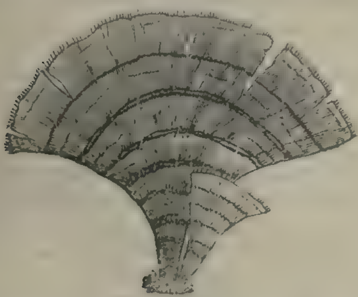
The *laminaria digitata* is the well known tangle so abundant on the British coasts. The stem is from one to six feet in length, and from a half to two inches in diameter; solid, very tough, and in old plants woody, expanding at the top into a flat frond, one to five feet or more in length, and about nine to twelve inches in width. In England it is known by the name of sea girdles. In Scotland, where the tender stalks of the young fronds are eaten, it is called

tangle; in Orkney it is known as *red ware,* and is the *stat-mhara,* or sea weed of the Scotch highlanders. Bishop Gunner mentions, that the fronds and stems of young plants are boiled and given to the cattle in Nordland. On many parts of the British coast it is collected and thrown in heaps, and in a putrescent state, extensively used as a manure. The dried stalks serve the inhabitants of the Orkney islands and the coast of Brittany for fuel. In Scotland, says Dr Neil, the stems are sometimes put to rather an unexpected use, the making of knife handles. A pretty thick stem is selected and cut into pieces about four inches long; into these, while fresh, are stuck blades of knives, such as gardeners use for pruning and grafting. As the stem dries it contracts and hardens, closely and firmly embracing the hilt of the blade. In the course of some months the handles become quite firm, and very hard and shrivelled, so that when tipt with metal, they are hardly to be distinguished from hart's horn.

The *laminaria esculenta* is the *badderlock* or *hen-ware* of Scotland, and the *honey-ware* of Orkney. The stem is about the thickness of a goose quill, from four to eight inches long; from this stem proceeds the frond, extending from three to twenty feet in length; a continuation of the stem forms the midrib, and on each side is a thin membrane from two to four inches in width. The midrib of the stem is eaten in the same way as the sea tangle; and this species is also employed as a manure.

Padina pavonia. Many of the algæ are of a

79.



very beautiful structure, few, perhaps, more so than this plant. The whole is beautifully marked with concentric zones, and when growing in the water, it decomposes the sun's rays, so as to assume an iridescent appearance.

The species represented in the Plate of Algæ are:

1. } Fucus vesiculosus
2. }
3. Fucus digitatus
4. Laminaria esculenta
5. ———— debilis
6. Himanthalia lorea
7. Halidrys siliquosa
8. Lichinia corfinis
9. Lichinia pygruga
10. Sargassum
11. Halyseris polypodioides
12. Halymenia ligulata
13. Enteromorpha compressa
14. Odonthalia dentata
15. Phyllophera rubens
16. Padina pavonia
17. Desmarestia ligulata
18. Dictyota
19. Dictyota dichotoma
20. Fustellaria
21. Chondrus crispus

Fungi are extremely variable in their form, consistence, and colour. They are fleshy or corky bodies, having sometimes a form which may be compared to that of an umbrella; in other words, composed of a *pileus* or head, which is generally convex, and is furnished beneath with perpendicular *laminæ* or gills, a central or lateral stalk, at the top of which is a circular membrane or *annulus,* which stretches along the circumference of the pileus. The whole mushroom is sometimes covered, previous to its development, by a kind of membranous bag, complete or incomplete, which is named the *volva;* at other times they are globular, ovoidal, or elongated masses, cup-shaped bodies, simple or articulated filaments, coralliform trunks, or bodies irregularly branched in the manner of coral, and of extremely variable colours, sometimes presenting the most lively tints; but their internal tissue, which consists of irregular cells, is never green. The sporules, or reproductive parts, are sometimes naked, sometimes inclosed in a kind of small capsules named *thecæ.* They are either scattered at the surface of the fungus, or enveloped in a *peridium* or receptacle, which is fleshy, membranous, or hard and woody. They are in general parasitical plants, which grow either on other vegetables still living, or in organic substances in a state of putridity, at the surface, or in the interior of the ground. They are, for the most part, of extremely quick growth, and their duration is often as fugitive; but some, as the *boletus,* vegetate slowly, and for several successive years. A very small number of species grow in water.

The fungi form several natural groups, which some authors consider as distinct families. These groups are the following:

1. Fungi or mushrooms properly so called: fleshy, corky, or woody plants, having the sporules placed in capsules, which form collectively a membrane, variously folded, and covering the surface of the fungus in whole or in part, as *agaricus, boletus, merulius, morchella, clavaria.*

2. The Lycoperdaceæ are formed of a fleshy or membranous peridium, at first closed, but afterwards opening and containing naked sporules, without capsules, and escaping from the peridium or receptacle under the form of powder,

such as *lycoperdon*, *geastrum*, *stemonitis*, *desmodium*.

3. The Hypoxyleæ, which have the appearance of tubercles or conceptacles, of very diversified forms, opening by a fissure or pore, and containing, in a kind of gelatinous pulp, small capsules *(thecæ)* full of sporules, as *hysterium*, *sphæria*, *erysiphe*.

4. The Mucedineæ.—Branched filaments crossing each other, and bearing sporules destitute of capsules, such as all the species of *mucor*, and the numerous genera into which they have been formed.

5. The Uredineæ.—The sporules are contained in capsules, which are either free, or placed without order upon the surface of a filamentous or pulverulent basis, as the *uredo*.

The family of fungi is distinguished from those of the algæ and lichens by the absence of any kind of frond or crust bearing the organs of fructification.

The fungi have in general the characteristics of vegetable bodies, yet, when analyzed, they yield the same products as animal matter, among the rest nitrogen, and in a state of putrefaction, give out a similar odour. Ammonia, the phosphoric salts, and albumen, very analogous to that of animals, are found in the fungi. It might be supposed that such substances are highly nutritious; this, however, is not the case, as they are among the most indigestible matters of food. Most of them are of a highly poisonous nature; and even those kinds which, in particular situations, are harmless, become poisonous by a change of soil. They differ from many noxious vegetables in this, that their poison cannot be separated by boiling, or even by distillation, which has been proved by the experiments of Parmentier. The fungi thrive best in the decomposing mass of vegetable bodies. Their seeds are exceedingly minute, and not easily detected even by the aid of the microscope, and therefore may be present in almost every organic product, in the vessels, fluids, and solid parts of both plants and animals. We have already alluded to the minute fungi in bread and fruits, constituting what is commonly called blue mould (page 5). These arise from innumerable minute seeds floating about in the atmosphere, or even carried along with the circulating fluids of plants or animals. The instant vitality ceases in them, the seeds of the fungi come into action. Accordingly, many species are most abundant in autumn, in rank and shady places, and in rainy weather, when decayed plants and insects may be presumed most to abound.

This class of plants is still very imperfectly understood, and the phenomena attendant on their mode of growth cannot be very well explained. Thus, as already remarked, locality has a marked influence on the nature of their juices, for it has been found, by fatal experience, that some species which are perfectly harmless when raised in open meadows and pasture lands, become virulently poisonous when they grow in contact with stagnant water, or putrescent animal and vegetable substances. What the poison in fungi may be, has not yet been accurately ascertained. Some of the *boleti*, which have the under sides of the caps formed of tubes instead of gills, yield even spontaneously crystals of oxalic acid, and others, as the *champignon*, are supposed to contain prussic acid. The nutritive part seems to reside in the *fungin*, and the poison and flavour in the acid, or at least in the juices of which the acid forms a part. Fungin is white, soft, and insipid. When burnt it smells like bread, and by distillation it yields a brown oil, water, ammonia, and charcoal. The charcoal contains phosphate of lime, some silica, with traces of phosphate of alumina, carbonate of lime, and sulphuretted hydrogen. Fungin, obtained from whatever species of fungi, has all these characteristics. This composition shows that it combines the nature of vegetable and of animal matter; and when it is allowed to putrefy in water, it has first the odour of putrefying vegetable gluten, and then that of a putrid animal substance. *Boletic acid* crystallizes in the form of irregular white prisms, does not alter when exposed to the air, is soluble in 45 times its weight of alcohol, and 80 times its weight of water, at the temperature of 68°. Its taste is somewhat similar to that of cream of tartar. The propagation and growth of the fungi are among the most curious subjects in the economy of nature. Their seeds or germs, too minute in general to be injured by any mechanical means, and having the power of resisting any common chemical process, remain in the earth, or in the vegetable substances, for an unlimited period of time; and they pass through the digestive organs of animals, or endure the action of heat, without sustaining the smallest injury. This is exemplified in paste made of flour, which produces mould or a species of fungi, as indeed does almost every vegetable and animal substance when it arrives at a certain stage of decay; and this development is only prevented by the action of the more active metallic salts. The fungi themselves, when they decay, are, as well as extraneous substances, subject in their turn to the attacks of other fungi. Montagu mentions a case in which the membrane that separates the lungs of an animal from the rest of the intestines, were covered with blue mould, even before death; but the membrane itself was diseased, and the surface dead. Minute fungi have been found growing from the bodies of living flies.

The quick growth of fungi is as wonderful as the length of time they survive, and the nume-

rous dangers which they will resist while they continue in the dormant state. To spring up "like a mushroom in a night," is a scriptural mode of expressing celerity, which accords wonderfully with observation. Mr Sowerby remarks, "I have often placed specimens of the *phallus caninus* by a window over night, while in the egg-form, and they have been fully grown by the morning;" while he adds, "they have never grown with me in the day time." From this and other analogous experiments it is not too wild a speculation to suppose, that if placed in the requisite circumstances as regards temperature, moisture, and absence of light, the whole earth would speedily be overrun with fungi. These substances sometimes grow in a singular manner, a remarkable instance of which is furnished in the fairy rings, which are found chiefly upon dry downs, and which are circles perfectly regular when the surface is uniform; but vanishing when they come to gravel or marsh. On these rings an innumerable array of fungi spring up in the latter end of summer. When the fungi are in progress the grass withers, and the ring has the appearance of having been trodden by invisible feet; hence its name. The distinction is however only temporary, for by the time that the rest of the grass is withered, that in the fairy path becomes green and vigorous, and a new circle is formed next season immediately outside. When two rings meet they do not cross each other, but unite, and gradually become an oval; but if a circle be interrupted by any small obstacle, such as a tree or a stone, it will unite again on the other side. These rings are formed by various species of mushrooms, and also by some of the *lycoperdons*, or puff balls; but the cause of the circular formation has not been satisfactorily explained. It would seem that the ground which has produced one crop of fungi is not immediately fit for the production of another, and thus the annual sowing is outwards. It also appears that the decayed matter of the fungi is favourable to the grass by which it is succeeded.

The kinds of fungi which are used as articles of diet in Britain are the truffle, the morel, and some species of mushroom; but in other countries, and especially in Russia, most species are eaten, even those which in Britain are the most deleterious, or at least the most acrid.

The *Truffle (tuber cibarium)*, is found growing in clusters, some inches under the surface of the ground, in a soil which is composed of clay and sand. It is nearly spherical, and without any visible root, of a dark colour, approaching to black, and studded over with pyramidal tubercles. The internal part is firm, and grained with serpentine lines. Its colour is white when young; but becomes black from age. Naturalists who have examined its structure with microscopic attention, affirm that minute oval capsules, each containing from three to four seeds, are embedded in its substance. Truffles are natives of the woods both of Scotland and England; but they are not produced in the same abundance, nor do they attain to equal perfection, with those which grow in some parts of the continent, and especially in Italy. When of more than three or four ounces in weight, they are considered large for the production of this country; but it is said that in Italy some are occasionally found weighing from eight to fourteen pounds. Since there is no appearance to indicate the particular spot where the truffles lie concealed, man calls the sagacious dog to assist him in his search after these subterranean delicacies. With much pains this animal has been trained to discover them by the scent; if successful, he barks and scratches the ground, when the gatherer follows and digs up the object of his pursuit. Truffles are used, like mushrooms, as an ingredient in certain high-seasoned dishes. They are esteemed the best of the fungi; but are confined in their locality, and have not hitherto been distributed by artificial culture. They are common in the downs of Wiltshire, Hampshire, and Kent.

The *Morel (phallus esculentus)*, see Plate III. fig. 3, is a spheroid, hollow within, reticulated with irregular sinuses on the surface, and of a yellowish colour, standing on a smooth white stalk, the whole rising to the height of about four inches. The substance when recent is wax-like and friable. It is used in the same manner as truffles, and when gathered dry, will keep for several months. The morel is a native of Britain, growing in damp woods and moist pastures, and coming to perfection in May or June. Gleditch mentions, that in some woods in Germany this fungus had been found in the greatest perfection in those parts where charcoal had been made. Acting upon this hint, the morel gatherers were accustomed to make fires in certain spots in the thicket; but these were sometimes attended with such serious consequences, that the magistrates found it necessary to interfere and forbid the practice. The morel is not, like the mushroom, made an object of culture; but Lightfoot says that he has raised it from seed. There is a fungus in Terra del Fuego which affords a staple article of food to the aborigines, and which is thus described by Mr Darwin: It is globular, of a bright yellow colour, of about the size of a small apple, and it adheres in vast numbers to the bark of the birch trees. It probably forms a new genus allied to the morel. In the young state it is elastic and turgid, from being charged with moisture. The internal skin is smooth, yet slightly marked with small circular pits, like those from the small pox. When cut in two, the inside is seen to consist of a white fleshy substance, which, viewed under a high

power, resembles, from the numerous thread-like cylinders, vermicelli. Close beneath the surface, cup-shaped balls, about one-twelfth of an inch in diameter, are arranged at regular intervals. These cups are filled with a slightly adhesive, yet elastic, colourless, quite transparent matter, and from the latter character they at first appeared empty. These little gelatinous balls could be easily detached from the surrounding mass, except at the upper extremity, where the edge divided itself into threads, which mingled with the rest of the vermicelli-like mass. The external skin, directly above each of the balls, is filled, and as the fungus grows old it is ruptured, and the gelatinous mass, which no doubt contains the sporules, is disseminated. After this process of fructification has taken place, the whole surface becomes honey-combed with empty cells, and the fungus shrinks and grows together. In this state it is eaten by the natives in large quantities uncooked, and when well chewed, has a mucilaginous and slightly sweet taste, together with a faint odour like that of a mushroom. Excepting a few berries of a dwarf arbutus, which need hardly be taken into the account, these poor savages never eat any other vegetable food besides this fungus. In New Zealand the root of the fern was consumed in large quantities before the introduction of the potatoe. At the present day probably Terra del Fuego is the only country in the world where a cryptogamic plant affords a staple article of food.

The *Mushroom (agaricus campestris)*, Plate III. fig. 2. This well known substance is common in Britain, as well as in most parts of the world. It is found throughout Europe, even in Lapland; in Asia as far as Japan, in Africa and America. It is the only species of mushroom cultivated as an article of food in this country. As some other poisonous kinds resemble it nearly, a minute description may not be without its use. The stem of the edible mushroom is short, solid, and white, marked a little below the cup with a prominent ring, the remains of the curtain which covers the gills in their early stage. The cup is at first white, regularly convex, and a little turned in at the edge. As it advances in growth, the surface becomes brown, scaly, and flattened. The flesh is white, firm, and solid; the gills are loose, reaching to the stem on all sides, but not touching it. When young, these are of a pinky red; but change to a livid colour about the same time that the cup alters its form, and the upper surface also changes colour. The latter circumstances distinguish it in this stage from the dark gilled toadstool, with which it might otherwise be confounded. This is the *champignon* of the French, and the *pratiole* of the Italians. It was well known and highly esteemed by the ancients. This species varies much in size, from two to eight or nine inches in diameter. In some parts of the northern counties of England a mushroom was gathered which measured thirty-four inches in circumference, and weighed upwards of a pound; another measured thirty-two inches in circumference, and ten inches round the stem, and weighed one pound eight ounces. The mushroom is chiefly used to communicate its peculiar flavour to ragouts, enters into the ingredients of sauces, or is served up by itself, prepared with a rich gravy. The button, or fleshy part, is the only portion employed, the stem, gill, and skin, being removed. Mushrooms are chiefly used for making the well known sauce catsup. For this purpose they are sprinkled over with salt, by which means a juice is obtained, which is afterwards mixed with spices, and boiled. The places where mushrooms chiefly grow are dry rich old pastures, where they are gathered in the autumn months. They exert considerable expansive force in growing. Some men in the isle of Wight, a few years ago, observed a large stone rising considerably at the interstices, and upon removing the pavement to discover the cause, found it to be occasioned by a mushroom, the vigorous efforts of which to increase upwards had forced the stone from its proper station.

In some parts of the country mushrooms are to be found in great abundance, and sometimes under circumstances and situations very unexpected. Some cultivators of a patch of potatoes, situated in a field in Derbyshire, proceeding to dig up their crop, found, to their great surprise, that a large quantity of fine mushrooms had sprung up among their potatoes; and in a small space of ground they gathered at least five pecks. The ground, previously to planting the potatoes, had been dressed with road scrapings, and with a small quantity of moss taken from off an old building. Indeed, in no case does it appear absolutely necessary to sow the visible seeds of these fungi. They seem to exist almost every where; and all that is requisite is a proper locality for their development. Some years ago such an abundant supply of this "voluptuous poison" was brought for sale to Preston, that immense quantities were sold at from threepence to fourpence per peck, and the smallest kind for pickles, at twopence per quart. Cartloads were purchased for the Manchester markets.

Although of so spontaneous and abundant growth in some situations and seasons, yet to obtain a regular and unfailing supply, mushrooms are, in most large gardens, raised artificially from the spawn or seed in an incipient state of growth; but wild mushrooms from old pastures are always considered more delicate in flavour than those obtained by garden culture.

Mushroom Spawn is a white fibrous substance, running like broken threads in any substance which is fit to nourish it; and this, scattered on

properly prepared beds, produces a plentiful crop. For this purpose, in June or July, to any quantity of fresh horse droppings, mixed with short litter, add one-third of cows' dung, and a small portion of mould to cement it together. Mash the whole into a thin compost, and spread it on the floor of an open shed, and let it remain till it becomes firm enough to be formed into flat square bricks; which being done, set them on edge, and frequently turn them till half dry. This being completed, level the surface of a piece of ground three feet wide, and of length sufficient to receive the bricks, on which lay a bottom of dry horse dung six inches thick; then form a pile by placing the bricks in rows one upon another, the spawned side uppermost, till the pile is three feet high; next cover it with a small portion of warm horse dung, sufficient in quantity to diffuse a gentle glow throughout the whole. When the spawn has spread itself through every part of the bricks, the process is ended, and they must be laid up in a dry place for use. Mushroom spawn made according to this process will preserve its vegetative power for many years, if well dried before it is laid up. If moist, it will grow and soon exhaust itself.

Mushrooms may also be raised in abundance on melon beds, by placing the *sporules* or spawn on the surface of the beds. This must be done when the bed is earthed up for the last time. The strong loamy soil used for melons is much more congenial to the mushroom than the light soil used for cucumbers; and if it is made still more firm by treading, it will be of very great advantage. Nothing more is required than to manage the bed and the melons as if no spawn had been used. The warmth of the bed will soon cause the spawn to run, and extend itself through the surface of the ground. In September or October following, when the melon plant is decaying, the bed must be carefully cleaned, the glass put on and kept close, and when the mould becomes dry it must be frequently watered, but not immediately, as too much wet would destroy the spawn; advantage should also be taken of every gentle shower, for the same purpose. The moisture coming up on the dry earth produces a moderate heat, which soon causes the mushrooms to appear in every part of the bed in such abundance as even to prevent each other's growth. Two bushels at a time have frequently been gathered from a bed ten feet by six, and have produced individual mushrooms of nearly 2 lbs. weight. This mould being kept warm by the glasses, and properly watered, the mushrooms will continue to spring till the frosts of winter prevent their further growth.

Besides the cultivated mushroom, there are about a dozen other species common to Britain, which are described as eatable.

The *agaricus pratensis* has a solid stem like the common mushroom, with the cap of a pale brown at the upper surface, and the gills yellowish. It grows on a moister soil than the common mushroom, and therefore is in itself to be looked upon with some suspicion. There is, however, another circumstance which renders the eating of this mushroom unsafe. On the upper surface it very much resembles the *agaricus virosus*, the most poisonous of all the tribe, and they both grow in similar situations. The gills of the poisonous fungus are, however, broader in proportion to the size of the plant than in the *pratensis*, and they are very dark coloured, or black. The fleshy part of the cap is also thinner, and there is a collar on the stem of the poisonous one; while that of the *pratensis* is naked. Many of the different species of agaric, are, however, so similar to each other, some being wholesome, while others are highly noxious, that persons who are not perfectly familiar with all their respective characteristics, should hesitate before they venture to gather the mushroom for use. In judging of the qualities of a mushroom, the smell is not a perfect or safe criterion. If the smell be nauseous, that is a good ground for rejection; but the opposite odour is no decided proof of innoxious qualities.

In other countries, many species of fungi are not only considered eatable, but are also made the objects of cultivation. A species of *boletus* is raised by the Italians, and for its production two kinds of stones are employed. The one is of calcareous formation, containing vegetable fibre, and is found on the chalk hills near Naples. The other is an indurated turf from the volcanic mountains near Florence. Both of these have the quality of imbibing moisture, and if either of them be kept in a cellar and constantly watered, it will produce this fungus; but the water with which they are moistened, must occasionally be that in which the boletus has been washed, and in which, of course, its seeds are contained. This proves that, under particular circumstances, some fungi have the power of elaborating their own substance out of moisture and the atmosphere. At Brescia, one species of fungus, *amanita incarnata*, is produced from the bruised fragments of the mushroom. The *agaricus ostreatus*, another eatable species, is obtained from the husks of the berries of the sweet bay, (*laurus nobilis.*) After the oil has been extracted by boiling, the husks are burned in a trench, and are then submitted to considerable pressure, and covered with a layer of earth about half a foot thick, and the whole is protected from excessive rain. From this trench mushrooms will spring up in October, and afford a supply during that and the two following months, for three successive years. At Genoa, mushrooms are produced in a similar manner, by

using the refuse of the olive presses. In the Landes of the south of France, the earth under oak trees is sometimes kept continually moist by water in which the *boletus edulis* has been boiled; whence, it is said, arises an abundant crop of that species which, we are told, resembles the cocoa nut in taste.

Agaricus muscarius, or *Fly-blown mushroom*, Plate XXXVIII. This splendid species is a native of Britain, and very abundant in Scotland. It has a large cap sometimes six inches in diameter, of a brilliant pink or crimson colour; beset with angular warts, and growing on a tall well proportioned stalk. It is very conspicuous even at a distance, in the shaded recesses of its native woods. "In the highlands of Scotland," says Dr Greville, "it is impossible not to admire it, as seen in long perspective between the trunks of the straight fir trees; and should a sunbeam penetrate through the dark and dense foliage, and rest on its vivid surface, an effect is produced by this chief of a humble race which might lower the pride of many a patrician vegetable. This mushroom is used by the inhabitants of the north-eastern part of Asia in the same manner as ardent spirits or wine, to promote intoxication. It is the favourite drug *moucho-more* of the Russians, Kamchadales, and Korians, who use it to promote intoxication. These fungi are collected in the hottest month, and hung up by a string in the air to dry. Some dry of themselves on the ground, and are said to be far more narcotic than those artificially preserved. Small deep coloured specimens thickly covered with warts, are also said to be more powerful than those which attain to a larger size, and are of a paler colour. The usual mode of taking this fungus is to roll it up like a bolus and swallow it without chewing, which the Kamchadales say would disorder the stomach. It is sometimes eaten fresh, in soups and sauces, and there loses much of its intoxicating property. When steeped in the juice of the berries of *vaccinium uliginosum*, its effects are the same as those of strong wine. One large, or two small fungi, is a common dose to produce a pleasant intoxication for a whole day, particularly if water be drank after it, which augments the narcotic excitement. The desired effect comes on one or two hours after taking the fungus. Giddiness and drunkenness result from the fungus in the same manner as from wine or spirits. Cheerful emotions of the mind are first produced, involuntary words and actions follow, and sometimes an entire loss of consciousness. It renders some persons remarkably active, and proves highly stimulant to muscular exertion; with too large a dose, violent spasmodic effects are produced. So very exciting to the nervous system in some individuals is this fungus, that the effects are often very ludicrous. If a person under its influence wishes to step over a straw or small stick, he takes a stride or a jump sufficient to clear the trunk of a tree. A talkative person cannot keep secrets or silence, and one fond of music is perpetually singing.

Agaricus comatus, or *tall cylindrical agaric*, Plate III. fig. 5. This is another handsome mushroom, and also a common one in autumn. Its pileus is bell-shaped, and from three to six inches long; the surface covered with large shaggy scales. In passing to decay it dissolves into a black fluid. If this fluid be collected and boiled with a little water, and a few cloves to prevent its becoming mouldy in keeping, and passed through a filtre, it furnishes an excellent bistre for painting, and it may be procured in any quantity.

The *puff balls*, (Scleroderma), Plate III. fig. 9, 22, are also well known species of fungi. In decaying the centre is reduced to a minute black powder or snuff, enveloped by the external cuticle, which in process of time bursts, and the whole mass containing the sporules or seeds, are dissipated to the winds.

The *carmine peziza*, (*P. coccinea*,) Plate III. fig. 17, is found attached to decaying trees, and rotten pieces of wood. It is a splendid cup-shaped fungus; the interior of the cup is lined with the brightest carmine.

LIST OF FUNGI, PLATE III.

1. Fly-blown mushroom.—*Agaricus muscarius.*
2. Common mushroom.—*Ag. campestris.*
3. Round headed morel.—*Morchella esculenta.*
4. Small headed morel.—*M. hybrida.*
5. Tall cylindrical agaric.—*A. comatus.*
6. Variable wood agaric.—*A. gilvus.*
7. Shaggy agaric.—*A. floccosus.*
8. Spangled watery agaric.—*Agaricus micaceus.*
9. Warty false puff ball.—*Scleroderma verrucosum.*
10. Large bladder-like peziza.—*P. vesiculosa.*
11. Alpine amanita.—*A. nivalis.*
12. Red stemmed boletus.—*B. luridus.*
13. Scaly hydrium.—*H. imbricatum.*
14. Hairy earth tongue.—*Geoflossum hirsutum.*
15. Hispid polyporus.—*P. hispidus.*
16. Sulphur coloured polyporus.—(*P. sulphureus.*)
17. Carmine peziza.—*P. coccinea.*
18. Scaly hydrium.—*Hydrium imbricatum.*
19. Pale crested agaric.—*A. cristatus.*
20. Mitral helvella.—*H. mitra.*
21. Tuberous agaric.—*A. tuberosus.*
22. False puff ball.—(*Scleroderma cepa.*)
23. Large stemmed peziza.—*Pez. macropus.*
24. Green and yellow agaric.—*Ag. psittacinus.*
25. Crisped helvella.—*H. leucophæa.*
26. Reticulated peziza.—*P. reticulata.*
27. Yellow spathularia.—*S. flavida.*

Lichens consist of a very simple kind of vegetation, being composed of fronds extended in the form of membranous crusts of varied consistence, simple or variously lobed; or of simple or ramified stems; or lastly, merely of a kind of powder: the sporules or seeds are inclosed in re-

ceptacles. These vary exceedingly in their form, which may be round, oval, linear, convex, concave; and in their colour, which is often brilliant: they are further sessile or stipitate, with or without a rim or margin. From these different modifications have been formed the numerous genera of this family, which were all included by Linnæus in the genus *lichen*.

The lichens are in general parasitical plants, living upon the bark of trees, or sometimes upon the moist ground, or even upon the bare rocks. Their substance is generally dry as if horny; and on being boiled is converted into a jelly, which is nutritious, and sometimes employed as food. The genera of this family are exceedingly numerous, and have been variously arranged according to the fancy of different authors.

The lichens, as they are in form among the simplest of plants, so they may be called the pioneers of the vegetable kingdom. The sporules of the lichen are furnished with a gummy and adhesive fluid, and being scattered about by the winds they fall upon bare rocks, and to these attach themselves. Without soil, and simply from moisture and the air, they vegetate and form a small central lichen; others grow in circles around, till, in process of time, the whole surface of the bare rock becomes covered with a hoary coat. These lichens periodically decay, and mouldering to the earth form with the particles of the abraded rocks a soil which is fitted for the reception of other plants further advanced in the scale of organization. Lichens also are found at the extreme points of vegetation, on the summits of high mountains, and near the poles, where all other vegetable bodies disappear. Humboldt mentions, that near the summit of Chimborazo, even within the limits of the snow line, the *umbilicaria pustulata* and the *verrucaria geographica* are seen growing on a shelf of rock: and these were the last traces of organised nature at such a height. The most remote land, the *Ultima Thule* of the southern hemisphere, that has been yet explored, constitutes a group of islands called New South Shetland, lying off the southern extremity of America, "Some of these islands," says the enterprising Captain Weddel, "afford scarcely any vegetation, save a short straggling grass which is found in very small patches on spots where there happens to be a little soil. This, with a moss similar to what is found in Iceland, appears in the middle of January, at which time the islands are partially clear of snow." A very beautiful lichen appears to be common there, bearing large, deep, chestnut-coloured fructifications, described under the name of *usnea fasciata*. It is the same lichen probably which is noticed by Lieutenant Kendal, when speaking of Deception island, one of this same group. "There was nothing," he says, "in the shape of vegetation, except a small kind of lichen, whose efforts seemed almost ineffectual to maintain its existence among the scanty soil afforded by the penguin's dung."

Tripe de Roche. An article of food extensively used by the Canadian hunters in the arctic regions of North American, is afforded by some species of lichen, all belonging to a distinct tribe of the liverworts, and now constituting the genus *Umbilicaria*. It was this which, under the name of *tripe de roche*, is described as supporting for many days our enterprising countrymen Captain Sir J. Franklin and Dr Richardson, and some of their companions, when they were in that country exposed to the most unparalleled hardships and sufferings from a want of every other aliment; while other individuals of the same party perished, incapable of subsisting on so wretched a diet.

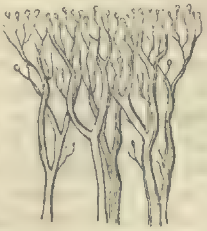
Iceland moss, (*Lichen islandicus*,) is used as an edible substance by the Icelanders, who rarely

79

obtain corn bread, and whose limited stock of substitutes obliges them to have recourse to every species of vegetable production, which is permitted by their inclement climate to spring forth. The plant is collected by the inhabitants of this northern region; and after being washed, is either cut into pieces, or it is dried by the fire or in the sun, then put into a bag which is well beaten. It is ultimately worked into a powder by being trampled on, and in this state is used as food. This lichen is found growing on the mountains both in the lowlands and highlands of Scotland. It consists of upright leaves nearly two inches high; soft and pliant when moist, but rigid when dry. They are smooth and shining, inclining to a red colour towards the roots, and having the exterior surface sprinkled with very minute black warts. The margins are set with small short stiff sporules. This lichen contains a nutritious matter called lichen-starch, along with a bitter principle. It is demulcent and tonic. When boiled and macerated in water, forms a nutritious and light jelly, which, with

the addition of sugar and milk, has been used as a dietetic medicine in cases of decline, and was fancied at one time as a cure for consumption.

80.



The *Reindeer moss*, (*lichen rangeferinus.*) This is also a valuable lichen, which grows in great abundance in the north of Europe, especially in Lapland. It constitutes almost the sole winter food of the rein-deer, that useful animal, without which the natives of that barren region could not exist. Linnæus assures us that this lichen grows so luxuriantly in Lapland, as to be found sometimes a foot in height. The rein-deer are so fond of it, that although it is covered up in winter under a great depth of snow, they will eagerly scratch it up with their feet and antlers. The plant is an exceedingly simple one; yet on it hinges the existence both of the rein-deer and the Laplanders. "Thus," remarks the great naturalist just mentioned, "things that are often deemed the most insignificant and contemptible by ignorant men, are, by the good providence of God, made the means of the greatest blessing to his creatures."

81.

Cud-bear, (*lichen tartareus.*) This small lichen grows abundantly in Sweden and Norway, where it is gathered for the purpose of the dyer.

Many other species of lichen, on being macerated in urine, afford dyes of various tints, chiefly red and brown. The more remarkable of these are *leucanora perella* and *tartarea, parmelia saxatilis* and *omphalodes, rocella tinctoria* and *fusiformis.*

The Hepaticæ are intermediate between the lichens and mosses. They are either spread out in the form of simple lobed membranes, through which runs a middle nerve, which has been considered as a stem; or they are composed of a small ramified stem bearing sessile leaves. The sporules are arranged in various ways, sometimes at the surface of the frond, sometimes at the base of the ramifications. As examples of this family we may mention the genera *marchantia, reccia, blasia, jungermannia.* Their properties are very little known, and none of them have been applied to any use.

The Musci, or Mosses. These plants, in their general aspect, resemble more the phanerogamic or flowering vegetables, than those we have just treated of. They are consequently a scale higher in the vegetable kingdom, and present the structure of roots, stems, fronds, or an approach to leaves, and more distinct organs of reproduction. They delight in moist and shady places, grow on the ground or the trunks of trees, or on walls and old buildings. Many of them are very minute, yet extremely beautiful; imitating all the ramifications of trees or shrubs. They are most verdant generally in winter, and during moist seasons; and put forth their flowers and various coloured tufts when other plants are inactive or denuded of their charms.

Though a very numerous family, there are few or none of the species directly conducive to the wants or luxuries of man; yet, they are doubtless not without their use in the great scheme of nature. In the temperate and northern regions they clothe the hill sides and valleys as with a soft green carpet; and by the growth and successive decay of certain species in our marshes, the accumulation of peat soil is formed.

The *Sphagnum palustre, hypnum cuspidatum,* and *bryum hypnoides,* are those plants which

82.

a. Sphagnum palustre; b. Hypnum cuspidatum.

chiefly contribute to the formation of peat moss. These mosses are particularly suited for the accumulation of this peculiar vegetable product. They grow to the height of five or six inches, when the lower stem begins to decay, and forms a soil from which the upper portion of the plant continues to vegetate. Thus a successive decay and fresh vegetation of the same stem goes on for many years, till a large accumulation of spongy vegetable matter is formed filling up the hollows between mountains, or ranging over marshy valleys. The formation of peat is peculiar to elevated, moist, and temperate regions. In hot climates dead vegetable matter is almost instantaneously decomposed, or reduced to its elementary principles; but in colder regions a partial decomposition only takes place where much of the woody fibre and many of the original combinations of the vegetable remain.

Peat consists of from sixty to ninety parts in the hundred of inflammable matter, resembling thus far the composition of coal: the residue is earthy matter, derived from an admixture of the soil in which it has been produced. Besides the mosses already mentioned, several lichens, heaths, rushes, and shrubs, and trees, enter into the formation of peat. Not unfrequently large trunks and roots of trees are found amid peat; and, indeed, whole forests have gradually fallen down and become converted into this substance. The rapidity with which large accumulations of this matter is formed, is also remarkable, considering the gradual process of the peculiar vegetation. We learn from a paper in the Philosophical Transactions, that in the year 1651, when the earl of Cromarty was nineteen years old, in travelling over the parish of Lochbrun he passed by a very high hill which rose in a gradual acclivity from the sea. At less than half a mile up from the sea there is a plain about half a mile in circumference, and from it the hill rises in a constant steepness for more than a mile in ascent. This little plain was at that time completely covered with a firm standing wood, which was so very old, that not only the trees had no green leaves, but the bark was quite thrown off, which the old countrymen, who were with his lordship, said was the universal manner in which fir woods terminated, and that in twenty or thirty years after, the trees would commonly cast themselves up from the roots, and so lie in heaps till the people cut and carried them away. About fifteen years afterwards, his lordship had occasion to come the same way, and observed that there was not a tree nor even a single root of all the old wood remaining; but instead of these, the whole bounds where the wood had stood was all over a flat green ground, covered with a plain green moss. He was told that nobody had been at the trouble to carry away the trees, but that, being all overturned from their roots by the winds, the moisture from the high grounds stagnated among them, and they had in consequence been covered over by the green moss. The place was so soft and spongy, that his lordship in attempting to pass over, sunk up to the shoulders. Before the year 1699, (in the space of forty-eight years) the whole piece of ground was converted into a moss, and the country people were digging peats out of it. At first they were soft and spongy, but gradually improved to the ordinary quality of peat. Extensive accumulations of peat are found in England, Ireland, and Scotland, and in many parts of the north of Europe. They exist partially in the southern countries of Europe, as France, Spain, and Portugal; but disappear as we approach towards the torrid zone. Peat moss, from containing a large proportion of tannin, is found to possess high antiseptic qualities; from this cause entire trees, with their seeds, and the bodies of animals, are frequently found at considerable depths, and after having lain for centuries, in a wonderful state of preservation.

As food or medicine, no species of moss is now employed, although formerly *polytrichum commune*, which is highly astringent, was used as a stimulant.

Much uncertainty still remains regarding the fructiferous organs of the mosses; we shall here only briefly allude to this subject, as we have treated it under the general view of the reproductive organs of the cryptogamia. Their sporules are inclosed in a kind of capsules named *thecæ*, which are supported upon a slender thread (*seta*,) and are at first enveloped in a kind of bag, which bursts circularly in the middle, and of which the lower part remaining at the base of the thread is named the *vaginula*, while the upper part which covers the top of the theca has received the name of *calyptra*. The theca itself presents internally a central axis named *columella*, and opens by means of a circular *operculum*. The circumference of the aperture of the theca is named the *peristome*, and is distinguished into internal and external. It may be furnished with teeth or ciliæ, closed by membranes, or entirely naked. Besides these organs, there are others of a different kind. These are irregularly oval and elongated bodies, supported upon a very short pedicle, and accompanied by articulated filaments.

The authors who have admitted in mosses the existence of flowers composed of the same organs as those of phanerogamous plants, have differed much respecting the functions of these organs, and the name which ought to be given to them. Thus Hedwig, whose labours have thrown so much light upon the history of plants of this family, considers mosses as furnished with male flowers and female flowers. The ovidal and vesicular bodies, intermingled with articulated filaments, he considers as male flowers, of which each is composed of a naked and pediculate grain of pollen. The thecæ, on the other hand, are female flowers. Palsot de Beauvois considers the theca as a hermaphrodite flower, of which the central columella is the pistil, and the granules which surround it the pollen. He considers what Hedwig calls male flowers as mere buds or bulbils of a peculiar nature. Dillenius, on the other hand, describes the theca as a male flower. Hill sees in it a hermaphrodite flower, the seminula of which are the ovules, and the ciliæ of the peristome are the stamina.

The Lycopodiums are intermediate in their general appearance between the mosses and the ferns. They are furnished with a branched, often spreading and creeping stem, and very numerous small leaves. The organs of fructification present two modifications. Sometimes

they are very small globular, trigonal or reniform, unilocular capsules, containing a great number of very small sporules. Sometimes these capsules are a little larger, open into two or three valves, and contain only three or four sporules of a large size. These two species of capsules, which may both occur on the same individual, are sometimes axillar and solitary, sometimes aggregated in the axil of bracteas, and then form simple or digitate spikes.

The genus *Lycopodium*, which forms the type of this family, was placed by Linnæus among the musci, and by Jussieu among the ferns. But the organization and position of the reproductive organs easily distinguish the lycopodiaceæ from these families.

The powder contained in the capsules of *lycopodium clavatum* and *selago* is very inflammable, and has been used in fireworks. No species of this family seems to be of any importance in an economical point of view.

FERNS are herbaceous perennial plants, sometimes becoming arborescent in the tropical re-

83.

Tree Fern.

gions, and then rising in the manner of palms. Their leaves or fronds are sometimes simple, sometimes more or less deeply cut, pinnatifid or decompound. These fronds present a common character, that of being rolled up like a crosier at their extremity, at the period when they begin to be developed. The organs of fructification are commonly situated on the lower surface of the leaves, along the nerves, or at their extremity. The sporules are naked or contained in a kind of small capsules. These capsules are aggregated into little masses, which are named *sori*. These sori are in the form of round kidney-shaped, sessile or stipitate scales, sometimes surrounded by an elastic ring, opening either at their circumference, or by a longitudinal slit, or bursting irregularly. In the genus *Pteris*, the sporules are placed under the replicate margin of the leaves, which forms an uninterrupted line. In the species of *adiantum*, they constitute small prominent and isolated plates, by means of the replicate margin of the leaves. In certain genera they are isolated, while in others they are aggregated, and form more or less elongated lines. The sori begin to be developed under the epidermis, which they raise in such a manner as to be covered by it. The portions of epidermis which thus form a covering to the sori are named *indusia*. In some ferns, such as the *osmundæ* and *ophioglossa*, the fructifications are disposed in clusters or spikes.

The genera of ferns at present known are very numerous, and form five natural sections:

1. *Polypodiaceæ.*—Capsules free, bursting in an irregular manner, surrounded by a narrow and prominent elastic ring, which terminates in a pedicle of greater or less length, as *polypodium, aspidium, asplenium, pteris.*

2. *Gleicheniæ.*—Capsules free, sessile, regularly arranged in a small number of groups, surrounded at the middle by a broad and flat elastic ring, opening by a transverse slit, as *ceratopteris, gleichenia, mertensia.*

3. *Osmundaceæ.*—Capsules free, opening by a longitudinal slit into two valves; no elastic ring: or, instead of one, a striated cup, as *anemia, lygodium, osmunda.*

4. *Marattieæ.*—Capsules sessile, aggregated, and united, so as to represent a many-celled capsule; no elastic ring, as *danæa* and *marattia.*

5. The *Ophioglosseæ.*—Capsules free, partly immersed in the frond, without elastic ring, and opening by a transverse fissure, as *ophioglossum, botrychium.*

Authors have varied much as to the nature of the reproductive organs in ferns. Almost all have considered the capsules as female organs. But some, as Micheli and Hedwig, have considered as male organs the glandular hairs which are sometimes seen on the young leaves. Others, with Hill and Schmidel, have called the rings of the conceptacles, stamina; and, lastly, others have given this name to the miliary glands and indusia.

Several species of fern have been employed as food, such as *ptesis esculenta, diplagium esculentum*, and *nephrodium esculentum.* The leaves of many species are mucilaginous, with a slight astringency, and some aroma. They have accordingly been used as expectorants. *Polypodium calaguala* and *crassifolium* are said to be medicinal, but are now rarely or never used. The stems of other species being bitter and astringent, have been used as anthelmintics. *Aspidium filix-mas, A. filix-fœmina*, and *pteris aquilina*, have been thus employed.

EQUISETA or *Horse-tail.* This small family is composed of the single genus *Equisetum.* All the species are herbaceous, perennial plants.

Their stems, which are simple or branched, are generally hollow, longitudinally striated, and present at intervals knots or enlargements, from which arises heaths which are slit into a number of shreds, and which seem to be verticillate leaves united together. Sometimes verticillate branches come off from these knots. The fructifications form terminal spikes. These spikes are composed of thick, peltate scales, similar to those which are observed in the male flowers of several coniferæ, and among others of the yew.

84.

Equisetum.

At the lower surface of these scales, grow a kind of capsules, disposed in a single row, and opening by a longitudinal slit which looks towards the axis. These capsules are filled with minute granules, which are composed of a globular part, from the base of which arise four long articulated filaments, enlarged at their upper part, and spirally rolled around the globular body, which is a true sporule.

Influenced by the similarity of form which exists between the reproductive organs of the equisetaceæ and the stamina of some coniferæ, Linnæus named these organs stamina, without pointing out the organs which he considered as pistils. Hedwig, on the other hand, considered each granule as a hermaphrodite flower; the globular part was the pistil, and the filaments were four stamina, the pollen of which was situated externally. The equisetæ are remarkable for the quantity of silica or flinty earth which they contain. A species of mare's-tail is very common in our marshes, and is sometimes cut for fodder; otherwise this family of plants are of no use to man.

Characeæ. The charæ are aquatic and submersed plants, found growing in our ditches, whose slender, branched, green, and sometimes translucid stems, bear at intervals verticillate branches, from eight to ten in number. On the branches of the upper verticles are observed a kind of *sporangia*, or capsules, three, four, or five in number. Each of them is surrounded at its base by two or three bracteas or abortive branches, which Linnæus considered as a calyx. They are unilocular, and contain numerous sporules, collected into a single mass, which has been considered as a single seed. These sporangia are formed of two integuments, of which the outer is membranous, transparent, very thin, and terminated above by five spreading teeth; the inner hard, dry, opaque, and composed of five small narrow valves spirally twisted. Besides these organs, there are also observed on the branches sessile and rounded tubercles of a reddish colour. Most authors describe them as stamina. They consist of a reticulated, transparent membrane, forming a kind of vesicle filled with a mucilaginous fluid, in which are observed articulated filaments of a whitish colour, and others of a larger size filled with a reddish fluid, closed at one of their extremities, and appearing to open at the other. These tubercles, in the progress of vegetation, shrivel, but do not open.

This family is composed of the single genus *Chara*. It was established by Vaillant, in 1719. Linnæus at first placed it in the class Cryptogamia, close to the lichens, but afterwards changed his mind, and referred it to monœcia monandria of the phanerogamic plants. The charæ are remarkable for the quantity of calcareous matter with which some of them are incrusted; but they are useless to man, either as food or medicine.

CHAP. XXV.

DIVISION SECOND, MONOCOTYLEDONOUS PLANTS.

In the previous chapter have been enumerated and described those vegetables which have a simple structure, and no conspicuous reproductive organs or blossoms: we now come to a second division of plants whose structure is more complex, and which are furnished with distinct male and female organs that produce true seeds.

Monocotyledonous plants. These are distinguished by the seed being composed of only a single cotyledon; besides this, there are the following distinctions:

The internal structure of the stem is composed of a mass of cellular tissue, in which are scattered bundles of vascular tubes.

The nerves of the leaves are generally parallel in the monocotyledons, while they are ramified, or branched, in the dicotyledons.

The perianth is always simple, there being only a calyx, which sometimes assumes the colours of a corolla.

The floral organs are generally three, or a multiple of this number, whereas five is the predominating number in dicotyledonous plants.

In their general aspect, these two great divisions of the vegetable kingdom differ considerably. The grains, grasses, reeds, palms, are in structure and general aspect totally unlike any families in the two-lobed division, and are readily distinguished from them.

There are twenty-seven families or groups of plants enumerated by botanists under the head of this division, which are as follow:

Nagadeæ. Water plants, as the *nagus*, *zostera*,

potamogeton, possessing no very remarkable properties, and of no economical use.

Aroideæ. Perennial herbaceous plants, generally with tuberous roots; many of them are acrid and poisonous; *acorus calamus* is aromatic. The root of *arum maculatum* or wake-robin, as well as that of others of this family, contains farina or starch.

Typhineæ. Aquatic, or arborescent and terrestrial plants, containing two genera, intimately allied in their properties to the family *aroideæ.*

Saurureæ, plants growing in the water, or floating on its surface. There are two genera, *saururus* and *aponogeton.*

Cabombeæ. Herbaceous perennial plants, growing in the fresh waters of America, consisting of two genera.

Cyperaceæ. Herbaceous plants, generally growing in moist places on the margins of lakes and streams; stem a cylindrical or triangular culm with or without knots; the leaves sheathing, containing the genera *scirpus, cyperus, schænus, mariscus, papyrus,* and many others. They resemble the grasses, but are of little or no economical use, with exception of papyrus, which furnished the ancient materials for paper.

Gramineæ. Herbaceous plants, annual or perennial; stem or culm generally hollow, and knotted with alternate, sheathing leaves; flowers disposed in spikes or panicles more or less branched. A family containing numerous and important genera, including the grains, as wheat, rye, oats, barley, maize, pannick, rice, millet; the grasses, sugar cane, bamboo, &c.

Palmæ or *Palms.* Large trees, with simple, cylindrical, leafless stems or *stipes*, crowned at their summits by a bundle of very large pinnate or decompound leaves, with leaflets of various forms. The flowers are hermaphrodite, or more commonly unisexual, diœcious, or polygamous. The cocoa, date, areca, sagus, are a few of the genera of this interesting and highly useful family.

Restiaceæ. Plants having the habit of rushes, many of them of peculiar genera, natives of New Holland.

Junceæ. Herbaceous plants, rarely annual, with simple, cylindrical, naked, or leafy stem; leaves sheathing at the base, sometimes entire, sometimes slit in their whole length. The flowers are hermaphrodite, terminal, disposed in the form of a panicle or cyme, and contained before their expansion in the sheath of the last leaf, which forms a kind of spatha for them. The genera are *juncus, lugula,* and *abama;* and they compose the well known plants called rushes.

Commelineæ. A small family allied to the *junceæ*, herbaceous, annual, or perennial.

Pontederiaceæ. Plants growing in the vicinity of water, bearing alternate, petiolate leaves, sheathing at their base; flowers solitary, or disposed in a spike or umbel, and springing from the sheath of the leaves which is slit. There are only two genera.

Alismaceæ. Herbaceous plants, annual or perennial; leaves petiolate, sheathing at the base; flowers hermaphrodite, rarely unisexual, disposed in spikes, panicles, or sertules. The foliage is generally acrid; the roots of some species are eatable. The genera are *butomos, sagittaria, lilias,* &c.

Colchicaceæ. Herbaceous plants, with a fibrous or bulbiferous root, and a simple or branched stem, bearing alternate sheathing leaves; flowers terminal; hermaphrodite or unisexual. All the plants of this family are more or less acrid, as *colchicum* and *veratrum*, which are used in medicine.

Asparagineæ. Perennial, herbaceous, or frutescent plants, with fibrous roots, alternate, opposite, or verticillate leaves; flowers sometimes unisexual, and variously disposed. Most of the genera are more or less acrid and stimulant; *dracæna draco* yields the gum-dragon, and *sarsaparilla* is a medicinal plant.

Siliaceæ. Plants with bulbous or fibrous roots, leaves sometimes all radical, flat, or cylindrical; hollow, or thick and fleshy; stem naked, flowers solitary and terminal, in simple spikes or branched racemes. The squill, garlic, onion, aloe, are examples of the genera.

Bromeliaceæ. Parasitic perennial plants, leaves alternate, and generally collected into a bundle at the base of the stem; elongated, narrow, toothed, and spinous on the margins; flowers scaly spikes, or branched racemes. The genera are *tellandsia, bromelia, agave, annana,* or pine apple, &c.

Dioscoreæ. Frequently climbing plants, leaves alternate or opposite, with irregularly ramified nerves; flowers hermaphrodite or unisexual. The yam belongs to this family.

Narcisseæ. Plants with a bulbous or fibrous root, and radical leaves. The flowers are solitary, often very large, disposed in sertules or simple umbels; enveloped before expansion in a membranous sheath. Among the genera are *narcissus, amaryllis, galanthus.* They are bitter, and generally nauseous. The bulbs of the common garden lily are emetic.

Irideæ. Plants generally herbaceous, with tuberous, fleshy, and rarely fibrous roots. The stem cylindrical, or compressed, with flat, ensiform, alternate leaves; flowers very large, enveloped previous to expansion in membranous sheaths, and solitary or variously grouped. The *iris, crocus, galaxia,* are examples of the genera. Saffron is the dried stigmas of a species of crocus.

Hemodoraceæ. Herbaceous perennial plants, sometimes stemless, having simple distichous leaves, sheathing at their base; and flowers dis-

posed in corymbs or spikes. This family is nearly allied to the preceding.

Musaceæ. Herbaceous or perennial plants, destitute of stem, sometimes furnished with a stype or cauliform bulb. Leaves on long petioles, amplexial at the base, entire at the margins. Flowers very large, often of the most brilliant colours, aggregated in great numbers, and contained in spathas. The genera are *musa*, *helicoma*, *strelitzia*, *urania*. The fruits of this family are used as food, and highly nutritive.

Amomeæ. Perennial herbaceous plants, of peculiar aspect, somewhat resembling the orchideæ; root often tuberous and fleshy; leaves simple, terminated at the base by an entire or slit sheath; flowers rarely solitary, accompanied with pretty large bracteas, forming dense spikes or panicles. The genera are *canna*, *maranta*, *thalia*, *phrynium*, *myrosma*, *amomum*, *zinziber*, *hellenia*, *costus*. Many useful aromatic substances are obtained from the roots and seeds of species of this family, as ginger, zedoary, cardamums. From the roots of several species of *maranta*, arrow root is obtained; from *amomum* the dye called turmeric.

Orchideæ. Perennial herbaceous plants, sometimes parasitic on other vegetables; root composed of simple cylindrical fibres, often accompanied by two tubercles; leaves simple, alternate, and sheathing; flowers often very large, and of a peculiar form; they are solitary, fasciculate, in spikes or in panicles. An extensive and beautiful family of plants, rather, however, ornamental than useful. *Orchis mascula* affords from its tubers the nutritive substance called salep.

Hydrocharideæ. Aquatic herbaceous plants, having the stem leaves entire or minutely toothed, sometimes spread out at the surface of the water; flowers contained in spathæ, generally diœcious, rarely hermaphrodite. *Valisneria*, *stratioles*, *othelia*, are genera of this family.

Nympheaceæ. Large beautiful plants floating on the surface of water, their stem forming a creeping subterranean rhizoma; entire alternate leaves, cordiform or orbicular, supported on very long petioles; flowers large, solitary. The genera are *nymphea* and *nuphar*.

Balanophoreæ. Parasitic plants, living on the roots of other vegetables; stem leafless, naked, or covered with scales; flowers monœcious, forming dense ovoidal spikes.

We shall now proceed to describe in detail, some of the most important families of this division of the vegetable kingdom.

CHAP. XXVI.

THE GRAMINEÆ,—WHEAT, BARLEY, OATS, RYE, RICE, MAIZE, THE GRASSES, &C.

The *gramineæ* form one of the most distinct and valuable families of plants, consisting of the different kinds of corn, the grasses, the sugar-cane, and bamboo.

The *Cerealia*, a genus of this family, so named from Ceres the goddess of corn, is the most important to man of all those into which vegetables have been divided. It consists of several species, all bearing a strong natural affinity to each other, and all resting their claims, as articles of nourishment, to the quantity of farinaceous or starchy matter which their seeds contain. That one among them upon which any people depends chiefly for its food, is called by that people corn, as wheat in England, oats in the northern lowlands of Scotland, rye in the sandy districts of the southern shores of the Baltic sea, rice and maize throughout the United States of America. To the family gramineæ also belong the grasses, so necessary for the support of herbivorous animals, especially those of the domestic kind; as also the sugar cane, which furnishes another important article of diet.

The cerealia, or corn plants, which we shal first notice, are all annuals, and herbaceous, the whole plant withering away after the seed has been produced and fully ripened. Sometimes this decay takes place in the stems and root before this latter process has been perfectly accomplished. Their stem is a culm or straw, which is hollow, and divided into lengths by nodes or joints; from these joints proceed alternate sheathing leaves, embracing the stem for some length. In order to give sufficient support to the light hollow straw, nature has bestowed a portion of silex or flinty earth, which enters largely into the composition of the outer layer of the culm. From this circumstance their ashes are found useful in imparting a polish to wood, horn, ivory, and even some of the softer metals; while, however, the presence of this silicious matter, and the great difficulty attending its separation from the purely vegetable fibre, have prevented straw from being employed in the manufacture of paper, for which it would otherwise be adapted. The last or terminatory leaf of the stem, constitutes a sheath to the newly formed flower, embracing it for a time so firmly, that the sheath cannot be opened without difficulty. With the growth of the flower it bursts open its protecting spatha, rises above it, and the leaf then turns backwards. The head or ear consists of an uncertain number of flowers; these are disposed in spikes or panicles. At the base are two scales, an outer and inner, forming the

lepicene (see cut 39, p. 66.); other two scales form the *glume.* The stamens, usually three in number, have capillar filaments, and the anthers are biped at both extremities. The pistil rises from a unilocular ovary, marked by a longitudinal furrow, and is surmounted by two styles, which terminate in two hairy and glandular stigmas. When the ear with its seeds is placed upon a single rib or rachis, it is called a spike, as in wheat; when the rachis is branched, as in oats, it is called a panicle.

The principal plants forming the cerealia are wheat, rye, barley, oats, millet, rice, maize; other cereal grasses, possessing the same farinaceous properties, are neglected only on account of the smallness of their seeds. None of this family possess any deleterious properties, with the single exception of the darnel *(lolium temulentum)*, a common weed in every field in Britain, whose deleterious qualities, though perhaps somewhat exaggerated, are undoubtedly ascertained.

Every civilized nation, from the earliest records, has sedulously cultivated grain. In the sepulchres of the most ancient of the Egyptian monarchs, which have been explored by modern travellers, was found the common wheat, in vessels which were so perfectly closed, that the grains retained both their form and colour. The wheat, buried there for several thousand years, affords a proof of the ancient civilization of Egypt as convincing as the ruins of temples and the inscriptions of obelisks. And yet, what is sufficiently singular, the corn plants, such as they are found under cultivation, do not grow wild in any part of the earth. Wheat has been traced, indeed, in Persia, springing up in spots, very remote from human habitation, and out of the line of the traffic of the natives; but this circumstance is far from proving that it is a production natural and indigenous to Persia. In Sicily there is a wild grass called *Œgilops orata*, which is found in particular districts. It has been held that the seeds of this plant may be changed into corn by cultivation; and that the ancient worship of Ceres, which considered the fields of Enna and of Trinacoria as the cradles of agriculture, had its origin in this transformation of the native grass. Professor Latapie of Bourdeaux affirms, that having cultivated the seed of the œgilops, the plant has changed its generic character, and has made approaches to that of wheat. Sir Joseph Banks, in a paper addressed by him to the horticultural society, in the year 1805, stated, that having received from a lady some packets of seeds, and among them one labelled "hill wheat," the grains of which were hardly larger than those of our wild grasses, but which, when viewed through a magnifying lens, were found exactly to resemble wheat, he sowed these grains in his garden, and was much surprised on obtaining, as their produce, a good crop of spring wheat, the grains of which were of the ordinary size. Every inquiry that was made to ascertain the history of these seeds proved fruitless. All that could be established with regard to the place of their production was, that they came from India; but as to the particular locality, or the amount of cultivation they had received, or whether the grain was indeed in that instance a spontaneous offering of nature, could not be ascertained. Experiments such as these may lead to the supposition, that in the corn plants, as in other vegetables, great modifications have been produced by cultivation; but they do not at all interfere with the belief that the cereal grains are spread over the earth by the agency of man alone; and that they are bequests from past ages of civilization too remote to afford any materials for the authentic history of their introduction even into countries possessing the most ancient records. Other seeds are dispersed throughout the earth by winds and currents, and various other ways; but the corn plants, in common with many other important vegetable productions, follow the course of man alone. This is a blessing which even hostile armies are instruments in diffusing. Cortez, the conqueror of Mexico, inhuman as he was in many parts of his conduct, thus writes from Mexico to the king of Spain: "All the plants of Spain thrive admirably in this land. We shall not proceed here as we have done in the isles, where we have neglected cultivation and destroyed the inhabitants. A sad experience ought to render us more prudent. I beseech your majesty to give orders that no vessel set sail for this country without a certain quantity of plants and grain." The diffusion of plants useful to man is an accident diminishing the evils of hostile invasion; it is a necessary attendant of commercial intercourse. The Indians of New England called the plantain "Englishman's foot;" and in the same way in the infancy of ancient society, wheat might have been similarly regarded as springing from the footsteps of the Persians or Egyptians. In times approaching nearer to our own, we know that wheat followed the march of the Romans, as the vine was in the train of the Greeks. And to come still nearer, we find cotton remaining in countries which had otherwise suffered from the incursions of the Arabs. Humboldt remarks, "that the migration of these plants is evident; but their first country is as little known as that of the different races of men which, from the earliest traditions, have been found in all parts of the globe."

The manner in which the most important gifts of Providence to mankind, says a recent writer,* have been diffused by the influence of conquest or commerce, has some striking instances in the

* Library of Entertaining Knowledge.

history of America. In the new world such facts are too recent to admit of any doubt. The same class of facts, too, are exhibited in several cases in the history of our empire in Hindostan. We shall give a few examples. None of the cereal grasses, properly so called, were found in cultivation among the Mexicans when their country was first visited by Europeans. The foundation of the wheat harvests at Mexico is said to have been three or four grains, which a slave of Cortez discovered in 1530, accidentally mixed with a quantity of rice. The careful negro, who preserved and made so advantageous a use of the few grains which a happy chance had thrown in his way, and which, in the hands of a careless or thoughtless person, would, with their future inestimable advantages, have been lost to his country, has not been thought worthy—doubtless because he was a negro—of having his name preserved. The Spanish lady, Maria d' Escobar, wife of Diego de Chaves, who first imparted the same blessing to Peru by conveying a few grains of wheat to Lima, has been more fortunate. Her name, together with the means which she took for effecting her object, by carefully distributing the produce of successive harvests as seed among the farmers, have been gratefully preserved in the records of history. The exact period when the cultivation was commenced in Peru is not indeed known; but it appears reasonable to believe that this event did not occur until after the date assigned for the introduction of wheat into Mexico, as in the year 1547 wheaten bread was hardly known in the important city of Cuzco. The first grains of wheat which reached Quito were conveyed thither by Father Josse Rixi, a Fleming, who sowed them near the monastery of St Francis, where the monks still preserve and show as a precious relic the rude earthen pot wherein the seeds first reached their establishment. The rice of Carolina is now the principal produce of that portion of North America. Mr Ashby, an English merchant, at the close of the 17th century, sent a hundred weight from China to this colony; and from this source all the subsequent rice harvests of that division of the new world, and the large exportations of the same valuable grain to Europe, have sprung. The wheat now cultivated at Rohilcund, in India, was propagated by seed brought from England, since the conquest, by Mr Hawkins; and the potatoe, within a very few years, has been extensively spread by us through the Indian peninsula, and thereby preventing the exclusive use of rice, is generally ameliorating the condition of the native population. Facts such as these are highly interesting, because they exhibit the moral as well as the natural causes which influence the distribution of vegetable food throughout the earth.

Before describing the different kinds of corn, it may be interesting to take a general view of their cultivation over the globe. The utmost limit of the culture of grain in Siberia reaches only to the 60° of latitude; and in the more eastern parts of the province these important products are scarcely to be met with higher than 55°. In the more southern parts of Siberia, and in districts adjoining the Wolga, the land is exceedingly fertile, so that crops of grain are obtained with a very trifling amount of labour. Buck wheat is very commonly cultivated in this district; and it is found that one sowing of the seed will produce five or six crops in as many successive years, each harvest yielding from twelve to fifteen times the quantity first sown. The seed which is shed during the reaping is sufficient to insure the growth of plants for the following year without any manuring, and with no more labour on the part of the farmer than that of harrowing the land in the spring. This system is continued without intermission until the diminished fertility of the soil compels its abandonment; but this state of things rarely occurs, until, as already stated, six years have thus been occupied. Europe is indebted to Siberia for a particular description of oats, which are considered excellent; and at Yakoutch barley is sometimes seen to arrive at maturity.

In some districts of Lapland, situated to the westward, the inhabitants are, by dint of careful tillage, enabled to produce plentiful crops of rye. In some spots nearer even than this to the pole, potatoes are made to supply the place of grain; but for the most part the inhabitants are constrained to subsist upon dried fish. In Kamtchatka, which is considerably to the south of Siberia, extending from 62° to 51° of north latitude, but united with that province at its eastern extremity, no attempts to cultivate the cereal grasses have ever proved successful, the produce not having in any case been sufficient to repay the labour of the tillage. These features may, however, be attributable more to the generally ungrateful nature of the soil than to the effects of an unkindly climate, since in some spots where the land is of better quality, other esculent vegetables are produced in tolerable perfection; cabbages, carrots, turnips, radishes, beet root, and even cucumbers, are reared constantly and without difficulty.

Barley and oats are the kinds of grain the culture of which extends furthest to the north in Europe. The meal which they yield, and which is seldom or never used by the inhabitants of South Britain for human food, forms, on the contrary, the principal sustenance of the inhabitants of Norway and Sweden, of a part of Siberia, and even Scotland.

Rye follows next in order, being associated with oats and barley in the more northern divi-

sion of the temperate zone. In the southern parts of Norway and Sweden, in Denmark, in districts bordering on the Baltic sea, and in the north of Germany, rye forms the principal object of cultivation, barley being raised in those countries, as with us, only for the purpose of brewing, and the use of oats being limited chiefly to the feeding of horses. In all these last mentioned places wheat is also grown; but its consumption is limited, and the principal part is made an object of internal trade.

The Norwegian summer, though short, is genial, and the sun is but a very few hours absent during the short night. Barley is here generally sown and reaped within the short space of sixty days, sometimes even six weeks are found to suffice for fulfilling the hopes of the husbandman. The Norwegian agriculturist is, however, occasionally visited by seasons throughout which the sun appears to lose its genial power, and vegetation is stunted, blossoms indeed appear, but are unsucceeded by fruits, and the straw yields nothing but empty ears. This calamity is happily of rare occurrence, and unless when checked by a premature frost, the harvests of Norway are for the most part abundant and excellent.

In Sweden agriculture is pursued in a systematic and scientific manner, by which means the natural barrenness of the soil is in a considerable degree remedied—the province of Gothland producing barley, oats, rye, and wheat, as well as pease and beans. In these climates the transition of the seasons is always abrupt. Vegetation, when it has once commenced, proceeds with a rapidity unknown in these more temperate regions; and the interval which elapses between committing the seed to the soil and gathering the ripened harvest, is scarcely greater in Sweden than is experienced in Norway. Somewhat farther to the south rye in a great measure disappears, and wheat becomes the principal grain used for human food.

France, England, the southern part of Scotland, part of Germany and Hungary, and the lands of western and middle Asia, fall within this description. In most of these countries the vine is also successfully cultivated, and wine forming a substitute for beer, the raising of barley is consequently much neglected. Still farther southward wheat is found in abundance; but maize and rice are also produced, and enter largely into the constituents of human food. Portugal, Spain, that part of France which borders on the Mediterranean sea, Italy and Greece, are thus circumstanced. Still farther to the east, in Persia and northern India, Arabia, Nubia, Egypt, and Barbary, wheat is indeed found; but maize, rice, and millet, form the principal materials for human sustenance. On the plains near the Caspian sea, in the province of Georgia, rice wheat, barley, and millet, are raised abundantly, and with little culture. In the more elevated parts of those districts rye is sometimes cultivated; but oats entirely disappear, the mules and horses being fed on barley.

The mode of culture followed at the present day in Egypt is exceedingly simple, and calls but for a small amount of labour. All that is required for raising barley and wheat is, when the inundation of the Nile has subsided, to throw the seed upon the mud. If this should be thought too hard and stiff, the grain is lightly ploughed in, and no farther care or culture is then required until the ripening of the produce, which usually happens from the beginning to the end of April. In Nubia, and particularly above the great cataract, the banks of the river are so high as seldom to admit of the overflowing of the waters; and the Nubian cultivators are consequently obliged to employ *sakies*, or water wheels, for the purpose of irrigating the fields during the summer. This practice prevails as far as Sumcar. The principal vegetable productions of Nubia are barley and *dhourra*, or Indian millet. The use of wheat is confined to the more wealthy inhabitants.

In China and Japan rice is the prevailing grain. This arises more from the peculiar tastes of the people than from climate, for in the Japanese islands, and in a considerable part of the Chinese empire, all the other grains might be advantageously raised. The dense population in China, and their restricted foreign trade, renders them so entirely dependent on their agriculture, that it is fostered in every way by their government. Thus we learn from their annals, that one of their greatest and wisest emperors was taken from his plough to ascend the throne. Another of their rulers is celebrated for having discovered the art of draining low lands, of collecting the water in canals, and of converting it from a noxious impediment to the useful purpose of irrigation. Their emperor Ven-li, who reigned one hundred and seventy-nine years before Christ, is said to have incited his subjects to the more zealous cultivation of their lands by ploughing with his own hands the land surrounding his palace, which example being followed by his ministers and courtiers, influenced in turn those who moved in a less exalted sphere.

Of the tropical countries Asia adopts principally the use of rice, while maize is more used by the Americans. This may arise from these substances being respectively indigenous to the two regions. In Africa the two grains are used nearly in equal proportions. Wheat is occasionally found within the tropics; but its scarcity and high price renders it more an object of luxury than common consumpt. In the upper provinces of British India, the wheat, though of a smaller grain than that used in Britain, is of excellent quality. Barley is also grown in the

more northern districts of India; but it, too, is of a diminutive size. The variety thus cultivated is the *bigg* of this country. Its cheapness renders it a common food for the native population, who make it into cakes.

The agriculture of the Hindoo Ryots is of a very primitive description. Their ploughs are scarcely deserving of the name, being merely a sharp pointed piece of wood, which scratches but does not turn over the soil; after the grain is scattered in, a branch of a tree serves as a harrow to cover it over. In seasons of drought, however, they have recourse to irrigation.

In America there is great diversity in the culture of the cerealia, corresponding to the diversity of climate in that continent. In the 57° and 58° of north latitude, barley and rye are brought to maturity; on the eastern coast, the same cultivation rarely succeeds higher than 50° or 51°. In the United States wheat and rye grow as in the more temperate regions in Europe; and it is perhaps owing to faulty methods of tillage, occasioned by the great abundance of land and the dearness of labour, that the produce bears a small proportion when compared with that obtained from cultivating the same extent of land in Europe. Great improvements in this respect have already been introduced; and when population shall be found, as in older settled countries, pressing against the means of subsistence, there is no reason why the lands should not be made as productive generally as they are in the carefully cultivated districts of this country. Maize is very extensively raised in the United States; and in the southern parts of the Union rice is also very largely cultivated.

Canada produces wheat in sufficient abundance to supply its own population, and to make large occasional shipments to the mother country, where this produce is received upon more advantageous terms, as regards the duty payable on importation, than wheat the produce of any part of the continent of Europe. In proportion as the lands of Canada are cleared of their timber, it is to be expected that a large amount of grain will be spared by that province for consumption in Europe, unless the tide of emigration should continue to set more and more strongly towards that quarter, so as to call for a proportionately increased quantity of grain for the sustenance of the settlers.

Humboldt, in his account of New Spain, has given a very interesting view of the agriculture of South America. In the lower latitudes of the Mexican republic, the cereal grains of Europe, comprehending under this denomination wheat, barley, oats, and rye, are never cultivated at a lower elevation than from 2500 to 3000 feet above the level of the sea. It is well known that the habitation of plants is determined in a very decided manner by the elevation of different regions. On this subject De Candolle calculates, that in France every 540 feet of vertical elevation is equivalent to a receding of one degree from the equator; while Humboldt estimates every rise of 396 feet to be equal to the same advance to the north in tropical countries. On the declivity of the Cordilleras, between Vera Cruz and Acapulcò, wheat cultivation does not in general commence at a lower level than 4000 feet. Sometimes, as in the immediate vicinity of the city of Xalapa, wheat is sown not for the sake of the grain, which indeed it there never produces, but because the straw and succulent leaves furnish excellent fodder for the cattle. It does not appear, however, that the degree of latitude and the amount of elevation are the only circumstances that determine the fructification of wheat, since in Guatemala, which is nearer to the equator, and at a much lower level than Xalapa, that grain comes to full perfection. Humboldt offers a reason for this variance from the usual rule, the exposed situation of the district, and the prevalence of cool winds, which serve to modify the otherwise unfavourable influence of the climate. I have seen, says this traveller, in the province of Caraccas, the finest harvests of wheat, near Victoria, at 1640 to 1968 feet of absolute elevation; and it appears that the wheaten fields which surround the Quatre Villas, in the island of Cuba, have a still smaller elevation. At the Isle of France wheat is cultivated on a soil almost level with the ocean.

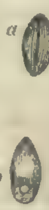
Circumstances altogether unconnected with climate must be taken into account in determining the relative agricultural capabilities of Mexico, where the absolute absence of rain throughout a large portion of the time when the plant is in the ground, must be in a high degree detrimental to wheat husbandry, unless artificial means were resorted to, as in Nubia, for supplying the natural deficiency of moisture. Throughout a great part of the temperate regions of New Spain the farmers are compelled to adopt the system of artificial irrigation. This is effected by the agency of canals and reservoirs, which are supplied from the rivers, and which are so constructed that the water may be dispersed at pleasure over any and every part of the farms. In districts where the system of artificial watering is fully adopted, the fertility of the Mexican farms is extraordinary, far beyond any thing experienced in the richest soils of Europe; the wheat harvest being commonly thirty-five and forty to one, and some considerable estates yielding even fifty and sixty measures for one measure of seed. In similar localities, and with land of equal quality, but where no opportunity has been provided for watering the fields, the annual return does not exceed more than fifteen or twenty for one. Maize is also very extensively cultivated in Mexico, and from the genial na-

ture of the climate and the general fertility of the soil, the returns which it yields to the farmer are most abundant. Humboldt writes that in the valley of Mexico the maize harvest yields two hundred for one. The Indians and Metizoes, who form a large proportion of the inhabitants of the republic, feed on maize and *manchol*, or the produce of the *cassava* plant, the consumption of wheat being principally confined to the white inhabitants of the towns. In the temperate and polar districts of the southern hemisphere, the order of cultivation is very similar to that pursued in similar latitudes and elevations north of the tropics. In America, wheat is commonly found in the southern provinces of Brazil, in Buenos Ayres, and in Chili. The same grain predominates at the Cape of Good Hope, the flour which it yields being of beautiful quality, and accompanied by less than the usual proportion of bran. In Australia, wheat also forms the principal object of cultivation on the part of the settlers; but in the southernmost portions of that vast island, or rather continent, and in Van Dieman's land, barley and rye are likewise to be found.

WHEAT. This is perhaps the most valuable of all the cerealia. As for the manufacture of bread, that "staff of human life," it possesses qualities superior to any of the other species of grain.

Triticum, or wheat, of which there are several species and varieties, is an annual herbaceous plant, possessing the usual characteristics of the gramineæ. The seed is a compressed oval, enclosed in a scaly pericarp, or chaff, from which it is easily separated. The cotyledonous matter is separated into halves by a deep groove (fig. *a*.), which runs along that side of the grain that, while the plant was attached to the ear, was placed next to the *rachis* or stem. On the other side, which is more convex, is seen an oval body, where the embryo is situated, and where the germ of the future plant springs from. The vessels by which the grain was attached to the parent plant, and by which it was nourished, were attached to this end of the seed lobe. When the seed is matured, these umbilical vessels separate, the point of separation then closes up, and the grain may then be easily detached from the chaff by which it is enveloped. There are two sorts of wheat generally cultivated in this country, *triticum hybernum*, or winter wheat, and *triticum æstivum*, spring or summer wheat.

85.



Winter Wheat has a large plump ear, smooth, or destitute of awn, with a conspicuous bloom, and a strong, vigorous, and erect stem. It is sown in autumn, begins to vegetate and remains green during the winter, and comes to maturity towards the end of the following summer. It is very apt to pass into varieties, arising from soil, climate, and modes of culture. Two of the most marked of them are the red and white wheat. The red wheat has a thicker and rougher envelope, is of a hardier nature than the other, and consequently more suited for cold and high situations; but it is less productive, and yields a flour of an inferior quality.

Winter Wheat.

Spring Wheat. This is supposed to have come from the north of Europe. It is less hardy than the winter wheat, the stem is more slender and delicate, the ear thinner and drooping, and furnished with beards or awns. This grain, which, in our uncertain climate, cannot be safely or productively cultivated throughout the kingdom, is yet domesticated in the more southerly and the midland districts. As its grain is smaller than that of the common winter wheat, and as its produce is less abundant, the farmer would not be led to its cultivation could he be certain of success with earlier sown seed, or if, in the progress of his agricultural operations, the land could always be got ready for the autumnal sowing. The principal advantage to be derived from the adoption of summer wheat consists in the security which it offers against the injurious effects of a cold and rainy spring; so that, in situations and seasons where winter sown wheat is so far injured as to destroy all prospect of a harvest, this delicate but more rapidly growing species may be more confidently depended on for yielding its increase. Some farmers, when they perceive that the seed which they have sown in autumn fails and goes off in patches from any untoward causes, are accustomed to rake spring wheat into the vacant spaces, and wherever the plants appear weak and thin. By this means the uniformity of the crop is restored; and if the operation has not been delayed beyond the beginning of April, the spring wheat will be matured, and ready for the sickle at the same time with the earlier sown plants. This mixture of grain is of no consequence to the miller; but it would of course be improper to employ the produce as seed. When spring wheat is sown by itself, the season for this operation is in April or the early part of May, from which time onward the farmer has but little to dread from any severity of weather. It is said that this species of wheat is not subject to blight. According to the analysis of Sir H. Davy, the nutritive quality of this kind is not quite equal to that of winter wheat, the proportions being 95½ per cent. in the latter, and only 94 per cent. in the former, of

the entire bulk of the grains. The gluten contained in the two kinds varies in a greater degree, that of winter wheat being 24, while that of spring sown corn is only 19, so that the winter variety is more eligible for the purpose of the baker.

Egyptian or many spiked Wheat (triticum compositum). This species of wheat, called also the "corn of abundance," is chiefly cultivated in Egypt and some parts of Italy. It is supposed to be of African origin, and in its qualities and habits resembles the spring wheat, above described, more than any other. The stem or rachis of this species is branched, and bears several ears or spikelets. The ear is bearded, and the grains are thinner than those of winter wheat. This kind will endure the extremes of moisture, as well as a high temperature, without injury, so that it is peculiarly adapted to the climate of the countries where it is chiefly raised.

87.

Egyptian or many spiked Wheat.

Spelt Wheat (triticum spelta). This is conjectured to have been the species of wheat used by the Romans, and the *zea* of the Greeks, although this latter name has been given to maize, a grain with which the ancients were totally unacquainted. This variety is still cultivated on the continent, and to a considerable extent in the south of Europe. A coarse soil will produce it, and it requires less culture and attention than the finer qualities of wheat. In many parts of Germany, in Switzerland, in the south of France, in the north of Africa, and at the Cape of Good Hope, spelt is raised in considerable abundance. It is also common in Spain, and is given to horses instead of barley, when that grain happens to be scarce. It is said, too, that this variety of wheat is well suited to the climate and soil of Australia. There are two varieties of spelt, one with awns, and the other quite bare. The spike of this latter variety is scantily supplied with grains, which have a very slight envelope of chaff, the individual grains, however, are large and plump. It is almost universally a spring sown crop, and grows luxuriantly, with a thick nearly solid culm. The bread made from it is of a dry quality.

One Seeded Wheat (triticum monococcum). This variety goes under the name of St Peter's corn. It is a very diminutive plant, and the spike contains only a single row of grains. It is cultivated in the more Alpine parts of Switzerland, and contains less gluten than the common sorts; on this account it is less adapted for the manufacture of bread, and is used in soups and gruels. The four-sided form of the ripe ear is so regular, that it has the appearance of being carved out of ivory. The stem, from its hardness and tenacity, is well adapted for thatching, for which purpose it is generally used. Several stalks grow up from one seed of wheat deposited in the soil, and the number varies much according to the manner of cultivation and other accidental circumstances. The power of renewing and multiplying the stems possessed by the grain-bearing plants, is called *tillering* by agriculturists. In its progress the stalks do not rise immediately from the germ, but are thrown out from different points of the infant sprouts while they are yet in contact with the moist soil. The increase of plants by this means is often most astonishing, and it is an admirable provision to repair and counteract the various casualties to which these plants are liable in the earlier stages of their progress. Among these casualties not the least common is that of the depredations of the wheat fly *(musca pumilionis).* This insect is in the habit of depositing its eggs in the very centre of the young plant, and when these are hatched into larvæ, the primary shoot is by these worms instantly devoured. Did the plant possess within itself no means of repairing this injury, the whole previous labour of the husbandman would in this case have been in vain. But this destruction occurring in the spring of the year, when the vegetative power of the plant is in the greatest activity, an effort is produced somewhat analogous to that of heading down a fruit tree, shoots immediately spring up from the divided part, the plant becomes more firmly rooted, and produces probably a dozen stems and ears, where, but for the temporary mischief, it might have sent forth only one.

88.

One Seeded Wheat.

Several extraordinary facts have been recorded in connection with the inherent power of multiplication possessed by these vegetables. Among others, Kenelm Digby asserted, in 1660, that "there was in the possession of the Fathers of the Christian doctrine at Paris a plant of barley, which they at that time kept as a curiosity, and which consisted of two hundred and forty-nine stalks springing from one root or grain, and in which they counted above eighteen thousand grains or seeds of barley." In the Philosophical Transactions it is recorded, that Mr C. Miller of Cambridge, the son of the eminent horticulturist, sowed, on the 2nd of June, a few grains of com-

mon red wheat, one of the plants from which had tillered so much, that on the 8th of August he was enabled to divide it into eighteen plants, all of which were placed separately in the ground. In the course of September and October so many of these plants had again multiplied their stalks, that the number of plants which were separately set out to stand the winter was sixty-seven. With the first growth of the spring the tillering again went forward, so that at the end of March and beginning of April a farther division was made, and the number of plants now amounted to five hundred. Mr Miller expressed his opinion, that before the season had too far advanced one other division might have been effected, when the number might have been at least quadrupled. The five hundred plants proved extremely vigorous, much more so than wheat under ordinary culture, so that the number of ears submitted to the sickle was 21,109, or more than forty to each of the divided plants: in some instances there were one hundred ears upon one plant. The ears were remarkably fine, some being six or seven inches long, and containing from sixty to seventy grains. The wheat, when separated from the straw, weighed forty-seven pounds and seven ounces, and measured three pecks and three quarters, the estimated number of grains being 576,840.

Such an enormous increase is not of course attainable on any great scale, or by the common modes of culture; but the experiment is of use as showing the vast power of increase with which the most valuable of vegetables is endowed, and which, by judiciously varying the mode of tillage, may possibly in time be brought into beneficial action.

The ordinary produce of wheat varies exceedingly, depending much upon the quality of the soil, the nature of the season, and the mode of culture. The average produce of the soil of a country depends, as does every other species of production, upon the advance of its inhabitants in knowledge and in the possession of capital. It has been conjectured, that in the 13th century an acre of good land in England would produce twelve bushels of wheat. In two centuries this rate of produce appears to have greatly increased. Harrison, writing in 1574, says, "The yield of our corne-ground is much after this rate following:—Throughout the land (if you please to make an estimate thereof by the acre), in meane and indifferent years, wherein each acre of rie or wheat, well tilled and dressed, will yield commonlie sixteene or twentie bushels; an acre of barley, six-and-thirtie bushels; of otes, and such like, four or five quarters; which proportion is notwithstanding oft abated toward the north, as it is oftentimes surmounted in the south." The mean produce in Great Britain, according to the estimate of Mr Arthur Young, did not, at the time when he wrote (about fifty years ago) exceed twenty-two and a half bushels per acre. Other and later writers have calculated the average at from twenty-four to twenty-eight bushels; while the author of the Reports on Agriculture for Middlesex has asserted, that the medium quantity in that county is forty bushels, the highest produce he has known being sixty-eight, and the lowest twelve bushels per acre. The land in the county which was the subject of these Reports, owing to its proximity to the metropolis, may be considered as in a state of high condition, and much beyond the ordinary rate of fertility. At all times, and in every country, some situations will be found more prolific than others, and some individuals will be more successful in their agricultural labours. Pliny has related a case which occurred among the Romans, where this success was seen in so marked a degree, that the able agriculturist who, by excelling his countrymen, had rendered himself the object of envy, was cited before the Curule Edile and an assembly of the people, to answer to a charge of sorcery, founded on his reaping much larger crops from his very small spot of ground than his neighbours did from their extensive fields. "In answer to this charge Cresinus produced his efficient implements of husbandry, his well-fed oxen, and a hale young woman his daughter, and pointing to them, exclaimed, These, Romans, are my instruments of witchcraft; but I cannot here show you my labours, sweats, and anxious cares."

It will easily be conceived that the quantity of straw must vary considerably from year to year, according to the seasons, and that this produce will likewise be generally influenced by the nature of the soil. It is therefore impossible to give any certain information upon this point; but it will perhaps amount to a near approximation to the truth, if we consider that for every twelve bushels of wheat, one load, containing thirty-six trusses of straw, will be obtained, the weight of which is 11 cwt. 2 qrs. 8 lbs. The straw of summer wheat is more agreeable to cattle than that produced from winter sowing.*

This most important vegetable is not wholly free from casualties apart from climate. The principal of these are blight, mildew, and smut, which we have already explained in the chapter on the diseases of vegetables.

There are two modes of sowing wheat practised by agriculturists. The one consists in scattering the grain from the hand over the well-ploughed fields, and is called sowing broad-cast; the other is by sowing it in uniform drills, or *dibbling* it, and afterwards hoeing and clearing it from weeds. This latter practice was attempted in the time of lord Bacon; but it was abandoned

* Library of Useful Knowledge.

on the score of expense. In 1669 Evelyn presented to the royal society a description of a sowing machine, invented by Locatelli, a native of Italy, who had obtained a patent for its use in Spain, having demonstrated its utility by public experiment. The drill plough, however, says a recent writer, was not used in England, and was perhaps quite unknown to a body of men who are proverbially slow all over the world to adopt any improvement, till public attention was awakened to it, in the early part of the last century, by the celebrated Jethro Tull, who, after practically following for some years his own improved plan of husbandry, and thereby proving its advantages, published a particular account of his process in the year 1733. This work, which he entitled "An Essay on Horse-hoeing Husbandry," became highly popular, compelling the attention of English agriculturists to the subject, and engaging no less the consideration of scientific foreigners. The system of Mr Tull consisted in discarding the old method of scattering seed upon the land broad-cast, and in substituting a mode of sowing the grain in straight rows or furrows, by means of an implement more perfect than Locatelli's machine, which delivered the seed at proper intervals, and in the exact quantity that was found most beneficial. Spaces of fifty inches breadth were left between the furrows, so that the land could be ploughed or horse-hoed in these intervals at various periods during the growth of the crop, the object of these hoeings being to bring fresh portions of the soil into contact with the fibrous roots of the plants, and thus to render every part in turn available for their nutrition. One material advantage that results from the new method of husbandry is the saving which it occasions in seed-corn, and which is said to amount to five-eighths of the quantity usually expended in the old method.

A bushel of wheat of the average weight, when ground into flour, yields the following produce:

	lbs.
Bread Flour,	47
Fine Pollard,	$4\frac{1}{4}$
Coarse Do.,	4
Bran,	$2\frac{3}{4}$
Loss,	2
	60

The method of making loaf bread, similar to that used in the present day, was known in the east at a very early period; but neither the precise time of the discovery, nor the name of the person to whom mankind is indebted for it, has been handed down to us. That the Jews knew how to make bread in the time of Moses, or above 1600 years before the commencement of the Christian era, is evident from the prohibition of the use of leavened bread during the celebration of the passover. There is no evidence that loaf bread was known to Abraham, for in his history cakes are frequently mentioned, but loaf bread or leavened bread never. It can scarcely be doubted that the Jews learned the art of making loaf bread from the Egyptians. The Greeks inform us that they were taught the method of making loaf bread by the god Pan. We learn from Homer that loaf bread was known during the Trojan war. Pliny tells us that no bakers existed at Rome till the year 580 after the building of the city, or about two hundred years before the commencement of the Christian era. Before that time bread was made in private houses, and was the business of the women. The only substance fit for making good loaf bread is wheat flour. It is the practice of some to mix this flour with potatoe starch; such an addition, however, cannot and ought not to exceed 30 per cent., otherwise the flour would not be fit for making bread.

The process of baking consists in mixing wheat flour with water, and forming it into dough. The average proportion is two parts of water to three of flour by weight; but this proportion varies considerably, according to the age and quality of the flour. In general the older and better the flour is, the greater is the quantity of water required. If the dough, after being thus formed, be allowed to remain for some time, the sugar of the farina undergoes a fermentation, being decomposed into carbonic acid and alcohol. The gluten which exists in every part of this dough prevents the carbonic acid from escaping; it therefore heaves up the dough in every part, and more than doubles its bulk. The fermentation, however, does not stop when the sugar is decomposed, it continues to act upon the alcohol, and gradually converts it into acetic and lactic acids. The consequence of this last action, which cannot be prevented on account of the slowness of the vinous fermentation of the dough, is, that it acquires a sour taste and smell, and if it be baked in the oven, though the loaf is full of eyes, and possesses the characters of loaf bread, yet its acid taste and smell render it disagreeable to the palate, and unfit for the purposes of food. Dough that has been allowed to ferment in this way is called *leaven;* but if a small quantity of this leaven be mixed with new made dough, and the mixture laid aside for a few hours, fermentation commences and goes on much more rapidly, so that the dough swells to at least twice its original bulk. If it be now put into the oven and baked, the fermentation is checked before any acid begins to be formed, and the bread is full of eyes, light, spongy, and sweet.

The ancient Gauls and Spaniards, as Pliny informs us, contrived another method of bringing on a fermentation in dough. Instead of leaven they added to the dough a quantity of the *yeast* or *barm*, which collects on the surface of fer-

menting beer. This addition occasions fully as speedy a fermentation as leaven, and it is not nearly so apt to give the bread a sour flavour. About the end of the 17th century the bakers of Paris began to substitute yeast for leaven. The practice was discovered, and declaimed against. The faculty of medicine, in 1668, declared it prejudicial to the health; and many years elapsed before the bakers were able to convince the public that bread raised by means of yeast is better than that fermented by leaven. Barm is now employed in preference to leaven in every civilized country. In this country the yeast used by bakers is made artificially, chiefly from potatoes. The process, according to Dr Thomson, is nearly as follows: A certain quantity of salt is dissolved in water, the temperature of which varies, according to circumstances, from 70° to 100°. Yeast is mixed with this water, and then a portion of flour is added, but always less than is ultimately employed in forming the finished dough. The mixture is covered up, and set apart in a warm place. Fermentation begins to be evident in about an hour. The *sponge*, so the imperfect dough is called, begins to swell up in consequence of the evolution of carbonic acid gas. This gas, being confined by the adhesive nature of the gluten, heaves up the sponge to twice its original bulk. Being no longer capable of containing this pent up gas, it bursts, and subsides. This alternate rising and falling of the sponge might be repeated a great many times; but unless the baker stops it after the second, or at the utmost the third dropping of the sponge, the bread invariably proves sour; he therefore, at this period, adds to the sponge the remaining quantity of flour, water, and salt, and incorporates these new materials with the sponge by a long and laborious course of kneading. After this the dough is left to itself for a few hours, during which time it continues in a state of active fermentation, diffused through every part of it. It is then subjected to a second, but much less laborious kneading, in order to distribute the imprisoned gas as equally as possible through the whole dough. It is now weighed out into the portions requisite to form the kinds of bread desired. These portions are shaped into loaves, and set aside for an hour or two in a warm situation. The fermentation still goes on, and gradually expands the mass to double its former bulk. They are now put into the oven and baked into loaves. The mean heat of the oven is about 448°. This heat immediately stops the fermentation; but the gas already generated is swelled out by the heat, and gives the loaf its characteristic vesicular structure. When bread is taken out of the oven it is lighter than when put in, from the evaporation of a portion of moisture during the baking. A portion of the starch, also, is converted into sugar.

89.

Rye.

Rye (*secale cereale*). This grain has an appearance something intermediate between wheat and barley. The ear is bearded, and the stem tall and slender. Four species of this plant are enumerated, *secale villosum, orientale, creticum*, and *cereale*. The last only is cultivated in Britain. The raising of rye was formerly much more practised in this country than at present. Two centuries ago rye flour, either alone or mixed with wheaten flour, formed the common bread of this country. Now this mixture is only partially used. At present rye is cultivated by our farmers principally that they may draw from it a supply of green food for their flocks. For this purpose the plants, which are sown in November, are eaten early in the spring, before they begin to spindle, which they will do towards the end of March. After this stage of the growth has taken place, the succulent quality of the blade is impaired, it becomes coarse and harsh, and is no longer agreeable to animals. When rye is left to ripen its seeds, these are, for the most part, applied in this country to purposes distinct from human food; the principal use to which the grain is put being the preparation of a vegetable acid, to be employed by tanners in an operation which they call *raising*, and whereby the pores of the hides are distended, so as to dispose them the more readily to imbibe the tanning principle of the oak-bark, which is afterwards applied. Rye, when parched and ground, has been recently used as a substitute for coffee. It would be difficult, however, to convince any one accustomed to the use of this grateful beverage, that the grain of home production is ever likely to take place, at least to any extent, of the fragrant Mocha bean. In fact rye contains neither the aromatic nor stimulating properties which render coffee so grateful.

Rye straw is useless as fodder, but forms an excellent material for thatching, and is so suitable for stuffing horse-collars, that saddlers will usually pay for it a very good price.

The *secale cereale*, which is said to be a native of Candia, was introduced into England many ages ago. There are two varieties of this species, occasioned more probably by difference of culture than by any inherent variation in the plants; one is known as winter, and the other as spring rye.

It was formerly usual to sow rye together with an early kind of wheat. The harvested grain, thus necessarily intermixed, was termed *meslin*, from *miscellanea;* it also obtained the

name of *mung-corn*, corruptly from *monk-corn*, because bread made with it was commonly eaten in monasteries.

With the exception of wheat, rye contains a greater proportion of gluten than any other of the cereal grains, to which fact is owing its capability of being converted into a spongy bread. It contains, likewise, nearly five parts in every hundred of ready-formed saccharine matter, and is in consequence easily convertible into malt, and thence into beer or ardent spirit; but the produce of this last is so small, in comparison with that of malted barley, as to offer no inducement for its employment to that purpose. Rye has a strong tendency to pass rapidly from the vinous to the acetous state of fermentation, and whenever that circumstance has intervened, it would be vain to attempt either to brew or to distil it. Unmalted rye meal is mixed in Holland with barley malt, in the proportion of two parts by weight of the former, with one part of the latter, and the whole being fermented together, forms the wash whence is distilled all the grain spirit produced in that country, and known throughout Europe as Hollands, Geneva. There must, however, be some circumstances of a peculiar nature connected with the process, as conducted by the Dutch distillers, since no attempts made elsewhere have ever been successful in obtaining a spirit having the same good qualities.

Rye is the common bread-corn in all the sandy districts to the south of the Baltic sea and the Gulf of Finland, furnishing abundance of food for the numerous inhabitants of places which, without it, must have been little better than sandy and uninhabited deserts. In these districts it not only forms the chief article of consumption, but furnishes a material of some consequence to the export trade of the Prussian ports.

The peasantry in Sweden subsist very generally upon rye-cakes, which they bake only twice in the course of the year, and which, during most part of the time, are consequently as hard as a board. Linnæus observed a curious practice in Lapland. One part of rye and two parts of barley being mixed together, the seed is committed to the ground as soon as the earth is capable of tillage in the spring. The barley shoots up vigorously, ripens its ears, and is reaped; while the rye merely goes into leaf without shooting up any stem, its growth being retarded by the barley, which may be said to smother it. After the barley is reaped, the rye advances in growth, and, without any farther care of the cultivator, yields an abundant crop in the following year.

This grain, to which so many human beings are thus indebted for aliment, is subject to a disease which, when it occurs, not only deprives it of all its useful properties as food, but renders it absolutely noxious, and, it may even be said, poisonous to man. When thus diseased it is called by English farmers *horned rye*, and by the French *ergot*, from the fancied resemblance to a cock's spur of an excrescence which the grain then bears. Whenever this disease has been witnessed, it has usually happened that a wet spring has been succeeded by a summer more than ordinarily hot. Tissot, a French physician, bestowed much attention on this subject, and upon its melancholy consequences. It is from him we learn that the excrescence just mentioned is an irregular vegetation, which springs from the middle substance, between the grain and the leaf, growing to the length of an inch and a half, and being two-tenths of an inch broad. It is of a brownish colour.

Bread which is made of rye thus diseased has an acrid and nauseous taste, and its use is followed by spasmodic symptoms and gangrenous disorders. These effects cannot by any means be classed among imaginary evils. In 1596 an epidemic prevailed in Hesse, which was wholly ascribed to the use of horned rye. Some of the persons who had unfortunately partaken of this food were seized with epilepsy, the attacks of which, for the most part, ended fatally; of others, who became insane, few ever fully recovered the proper use of their senses; while some, who were apparently restored, were liable through life to periodical returns of their disorder.

Similar calamities were experienced in different parts of the continent at various times, between 1648 and 1736, and these visitations have been recorded by Burghart, Hoffman, and others. In 1709, this diseased condition of the rye occurred in a part of France to such a degree, that in consequence of it no fewer than five hundred patients were at one time under care of the surgeons at the public hospital at Orleans. The symptoms first came on with all the apparent characteristics of drunkenness, after which the toes became diseased, mortified, and fell off. The disorder thence extended itself up the leg, and frequently attacked the trunk, and this sometimes occurred even after amputation of the diseased limbs had been performed, with the vain hope of stopping the progress of the disorder.

The poisonous quality of horned rye is not exerted upon human beings alone, both insects and larger animals having been fatally affected by it; even flies, that merely settled casually upon the grain, have been killed by that means; and deer, swine, and different kinds of poultry, upon which experiments were tried, all died miserable deaths, some in strong convulsions, and others with mortified ulcers. These circumstances must have been truly appalling by their severity and the frequency of their recurrence. Few evils, however, are wholly of an

unmixed character, and this one is not of the number. *Ergot* of *rye*, which was formerly productive of so much misery, has since found admission as a medicine into our pharmacopœias; it acts powerfully on the uterus, and is now, in the hands of skilful and honest practitioners, rendered subservient to the interests of society. Horned rye is of very rare occurrence in Great Britain.

BARLEY *(hordeum)*. This species of grain has a seed of a slenderer form, and a rougher covering or husk than that of wheat; the awn too is larger and more serrated than any of the other species of corn. Barley differs still more from wheat in containing more farina or starch, much less gluten, and about 7 per cent. of uncombined saccharine matter, which latter wheat does not possess previous to germination.

Next to wheat, barley is in this country the most important grain, being used chiefly in the formation of fermented liquors and spirits. There are four distinct species of barley, besides numerous varieties: ***hordeum vulgare***, or spring barley; ***hordeum hexasticon***, winter or square barley; ***hordeum distichon***, long-eared barley; ***hordeum zeocriton***, sprat or battle-dore barley.

The Egyptians have a tradition that barley was the first of the cerealia made use of by man, and trace its introduction to their goddess Isis. The native country of barley, however, is as little known as that of wheat. Some travellers have mentioned it as being produced in a wild state in distant parts of the world; but there is reason for believing that all statements to this effect have been founded in error, since the hardiest varieties of the cultivated grain have never yet been seen to propagate themselves during two following years. The seed of cultivated barley, when chance-sown, will indeed produce plants; but the grains which these bear are rarely, if ever, seen to germinate. Some grasses which have been placed by botanists in the same genus with barley, bear to it a strong outward resemblance; yet none of them can, by any degree of culture, be brought into use as human food, nor indeed be made to exhibit any marked improvement. One of these grasses, the ***hordeum murinum*** of Linnæus, known commonly as wall-barley, bears the nearest resemblance of any to the cultivated plant.

In one respect barley is of more importance to mankind than wheat. It may be propagated over a wider range of climate, bearing heat and drought better, growing upon lighter soils, and coming so quickly to maturity, that the short northern summers, which do not admit of the ripening of wheat, are yet of long enough duration for the perfection of barley. It is the latest sown, and the earliest reaped of all the summer grains. In warm countries, such as Spain, the farmers can gather two harvests of barley within the year, one in the spring from winter-sown grain, and the other in autumn from that sown in summer. Barley sown in June is commonly ready for the sickle in three months from the time of the seed being committed to the ground; and in very northern climates the period necessary for its growth and perfection is said to be of still shorter duration. Linnæus relates, in his tour in Lulean Lapland, that on the 28th of July he observed the commencement of the barley harvest, and although the seed was sown only a few days before midsummer, that the grain was perfectly ripe, the whole process having thus occupied certainly not longer than six weeks.

The property of not requiring moisture admirably fits barley for propagation in those northern countries, where the duration of summer is limited to a very few months in the year, and where wet is of very rare occurrence from the time when the spring rains are over, at the end of May or the beginning of June—after which period the seed-time commences—until the autumnal equinox, previous to which the harvest is reaped.

So hurtful is excessive moisture to the plants, that even heavy dews, if of frequent occurrence, are found injurious. Wet is detrimental at all periods; but the mischief is exhibited in a very different manner, according as it occurs before or after the formation of the ear. If, during the former stage, the leaves, as already mentioned, will become yellow and sickly, and the ears will probably not make their appearance; whereas, if these should already have been formed, and completely filled when visited by rain, the grain will sprout in the ear; and should the weather which follows be warm and genial, this growth will be so rapid that the ears will put on the appearance of tufts of grass. Barley is besides very liable to be beaten down by rain and to lodge; and should this occur after the filling of the ear, germination of the grains will take place to such a degree that the first growth will be completely rotted and destroyed by the second. Gentle showers, however, if of short continuance, and if they do not happen either very early after the plant is above the ground, or during the time of blooming, or when the ear is full, are rather beneficial than hurtful. It is worthy of remark that the very quality which renders barley so precarious a crop in unsettled climates, imparts to it likewise its chief value. The facility with which the grain is made to germinate is favourable to the operation of converting it into malt, which is, in fact, simply the process of germination induced and carried forward up to and not beyond the point when the maximum quantity of saccharine matter is developed in the grain.

SPRING BARLEY—*Hordeum vulgare*—is the kind most commonly cultivated in England. Of this species farmers distinguish two sorts; one

90.

Spring Barley.

the common, and the other the *rath-ripe* barley. These, in fact, are the same plant, the latter being a variety occasioned by long culture upon warm gravelly soils. If seeds of this kind are sown in cold or strong land, the plants will ripen nearly a fortnight earlier than seeds taken from other strong land; but this holds good only during the first year. This variety is said in extraordinary seasons to have been returned to the barn within two months in this country. Siberian barley, another variety, was brought into culture in the year 1768, by Mr Haliday, who received a very small portion out of about a pint of seed which had been presented by a foreign nobleman to the London Society for the Encouragement of Arts. This variety exhibits, on first coming up, a broader blade, and is of a deeper green than common barley. The ears are shorter, containing only from five to nine grains in length, while the common sort has from nine to thirteen grains. Siberian barley arrives at maturity about a fortnight earlier than other kinds.

91.

Winter or Square Barley.

Winter or Square Barley, called also Bear, or Bigg—*Hordeum hexastichon*—is the second species, (β). This is rarely cultivated in the southern parts of England; but in the northern counties and in Scotland is very generally sown, being a much more hardy plant than spring barley. The grains are large and plump, and the spike is thicker and shorter than the last-described species, being seldom longer than two inches, and square. Maltsters in the southern division of the kingdom are of opinion that this barley does not answer their purpose so well as that more usually cultivated among them, while in Scotland this idea is considered to be an unfounded prejudice.

The number of grains in each ear is greater than are found on spring barley in the proportion of three to two, one ear frequently yielding forty or more grains. These are disposed in six rows, two of these being on each of two sides, and one row on each of the other sides.

92.

Long-Eared Barley.

Long-eared Barley, sometimes called Two-rowed Barley—*Hordeum distichon*—is partially cultivated in every part of England, and is a very good sort. Some persons object to it, that the ears being long and heavy, it is more apt to lodge than other kinds. The grains are regularly disposed in a double row, lying over each other like tiles on a roof, or like the scales of fishes. The ear is somewhat flatted, being transversely greater in breadth than in thickness. The husk of the grain is thin, and its malting qualities are excellent.

Sprat or Battledore Barley—*Hordeum zeocriton*—has shorter and broader ears than either of the sorts already described; its awns or beards are longer, so that birds cannot so easily get out the grains, which also lie closer together than those of other kinds. Sprat barley seldom, if ever, grows so tall as either of the other species, and its straw is not only shorter, but coarser, so as to render it not desirable for use as fodder.

It was formerly the universal practice in this country to sow barley in the spring. The end of March or beginning of April was the more usual time, but the sowing was sometimes deferred to the beginning of May. The practice in this respect has somewhat varied of late, and a more early season has been chosen for sowing, so that it is not uncommon for the process to be performed in January, under the idea that the produce in such cases is greater. In the county of Norfolk, where the cultivation of barley is carried forward very extensively, and with the greatest skill, the farmers were formerly guided in their choice of seed time by a maxim which had long been handed down to them from father to son:—

> "When the oak puts on his gosling gray,
> 'Tis time to sow barley night and day;"

meaning, that when the oak exhibits the gray appearance which accompanies the bursting of its buds, a few days preceding the expansion of the leaves, it is then improper to lose any time in getting their seed-barley into the ground. The budding and leafing of the birch trees is, in Sweden, considered an indication of the proper time for barley-sowing. In different countries there are, of course, different natural guides in the operations of husbandry; but an intelligent and observing farmer, in every country, will not fail to regard those which have been sanctioned by

experience; while the agriculturist, who is bound by a servile adherence to particular months and even weeks for his operations, will unwisely treat as old saws such relics of the practical skill of our forefathers as the lines we have quoted. Linnæus, the great Swedish naturalist, constantly exhorted his countrymen to observe at what time each tree unfolds its buds and expands its leaves. In our own country, Mr Stillingfleet, an eminent naturalist, made a series of very accurate observations upon this interesting appearance of the spring. A farmer who would keep a calendar of Nature in the same manner for a few years, and at the same time register his days of sowing and the issue of his harvest, would secure, no doubt, a valuable collection of rules for his guidance, peculiarly applicable to the exact circumstances of situation and soil amidst which he pursues his calling.

The produce of barley, according to the quality of the soil, is from three to four quarters to the acre. A larger produce is not unfrequent; and even so much as seven quarters have been reaped in very favourable seasons and situations.

The average weight of a Winchester bushel of barley is between fifty and fifty-one pounds, and the same measure of bigg weighs but little more than forty-six pounds. It is very seldom that the former is found to weigh beyond fifty-two, or the latter beyond forty-eight pounds to the bushel. The average length of a grain of barley, taking the mean of many thousand measurements, is 0.345 inch, while that of a grain of bigg is 0.3245 inch. The medium length of these two species gives, therefore, as nearly as possible one-third of an inch, which agrees with the lowest denomination or basis—the barley-corn of our linear measure.

The purposes to which barley is principally applied in this kingdom are those of brewing and distilling. Some portion is still brought more directly into consumption as human food; but this portion, for the most part, now undergoes the previous process of decortication (removal of the bark), whereby it is converted into what is called Scotch or pearl barley. This grain, in its raw state, is also used to some extent for feeding poultry and fattening swine, for which latter purpose it is commonly converted into meal. The ancients were accustomed to feed their horses upon barley, as is the case among the Spaniards to the present day; and Pliny relates (Book xviii. c. 7,) that the Roman gladiators were called *Hordearii*, from their use of this grain as food.

The use of barley in the preparation of a fermented liquor dates from the very remotest times. The invention of this preparation is ascribed to the Egyptians by ancient Greek writers, one of whom, Dioscorides, attributes the first cultivation of barley to the same people, under the guidance of Osiris; while Herodotus informs us that the people of Egypt, being without vines, made their wine from barley. Pliny, in his Natural History, gives the Egyptian name of this liquid as Zythum. An intoxicating liquor is still made from this grain, both in Egypt and Nubia, to which the name of *bouzah* is given. This is of very general consumption among the lower rank of people. Burckhardt observed another use to which barley is applied in the latter country. The green ears are boiled in water, and served up to be eaten with milk. Among the Greeks beer was distinguished as *barley wine*, a name which sufficiently identifies the intoxicating property of the liquid, and the material whence this was drawn. From a passage in Tacitus we learn that the German people were, in his day, acquainted with the process of preparing beer from malted grain; and Pliny describes a similar liquid under the name of Cerevisia, an appellation which it retained in Latin books of more recent date. It farther appears that malt liquor has formed an article of manufacture and consumption in this country for a period at least coeval with the time of Tacitus; but we do not know whether any one kind of grain was exclusively employed in its preparation, or whether wheat and barley were not used for the purpose, either indiscriminately or in conjunction.

The general drinks of the Anglo-Saxons were ale and mead: wine was a luxury for the great. In the Saxon Dialogues preserved in the Cotton Library in the British Museum, a boy, who is questioned upon his habits and the uses of things, says, in answer to the inquiry what he drank—"Ale if I have it, or water if I have it not." He adds, that wine is the drink "of the elders and the wise." Ale was sold to the people, as at this day, in houses of entertainment; "for a priest was forbidden by a law to eat or drink at *ceape-alethetum*, literally, places where ale was sold." After the Norman conquest, wine became more commonly used; and the vine was extensively cultivated in England. The people, however, held to the beverage of their forefathers with great pertinacity; and neither the juice of the grape nor of the apple were ever general favourites. "The old ale knights of England," as Camden calls the sturdy yeomen of this period, knew not, however, the ale to which hops in the next century gave both flavour and preservation. Hops appear to have been used in the breweries of the Netherlands in the beginning of the fourteenth century. In England they were not used in the composition of beer till nearly two centuries afterwards. It has been affirmed that the planting of hops was forbidden in the reign of Henry VI.: and it is certain that Henry VIII. forbade brewers to put hops and sulphur into ale. In the fifth year of Edward VI., the royal and national taste appears to have

changed; for privileges were then granted to hop-grounds.

In the reign of James I. the plant was not sufficiently cultivated in England for the consumption; as there is a statute of 1608 against the importation of spoilt hops. In 1830, there were 46,727 acres occupied in the cultivation of hops in Great Britain.

Of barley, there are above thirty million bushels annually converted into malt in Great Britain; and more than eight million barrels of beer, of which four-fifths are strong beer, are brewed yearly. This is a consumption, by the great body of the people, of a favourite beverage which indicates a distribution of the national wealth, satisfactory by comparison with the general poverty of less advanced periods of civilization in our own country, and with that of less industrious nations in our own day.*

Malt. This term is applied to barley, or other grain, which has been made to germinate artificially to a certain extent, after which the process is stopped by the application of heat. In the manufacture of malt, the barley is steeped in cold water for a period which, as regulated by law, must not be less than forty hours, but beyond that period the steeping may be continued as long as is thought proper. There it imbibes moisture and increases in bulk, while at the same time a quantity of carbonic acid is emitted, and a part of the substance of the husk is dissolved by the steep water. The proportion of water imbibed depends partly on the barley, and partly on the length of time that it is steeped. From the average of a good many trials, it appears that the medium increase of weight from steeping may be about 47 lbs. in every 100 lbs., the average increase of bulk is about a fifth. The carbonic acid emitted while the barley is in the steep, is inconsiderable, and probably is derived from the oxygen of the steep water. The water gradually acquires a yellow tinge and the smell and taste of water in which straw has been steeped; these qualities are derived from the extractive matter of the husks of the barley.

After the grain has remained a sufficient time in the steep, the water is drained off, and the barley thrown out of the cistern upon the malt floor, when it is formed into a rectangular heap about sixteen inches in depth, called the *couch*. In this situation it is allowed to remain about twenty-one hours. It is then turned by means of wooden shovels, and diminished a little in depth. This turning is repeated twice a day, or oftener, and the grain is spread thinner and thinner, till at last its depth does not exceed a few inches. When placed on the couch it begins gradually to absorb oxygen from the atmosphere, and to convert it into carbonic acid, at first very slowly, but afterwards more rapidly. The temperature at first, the same with that of the internal air, begins slowly to increase, and in about 96 hours the grain is at an average about 10° hotter than the surrounding atmosphere. At this time the grain, which had become dry on the surface, becomes again so moist that it will wet the hand, and exhales at the same time an agreeable odour, not unlike that of apples. The appearance of this moisture is called sweating. A small portion of alcohol appears volatilized at this period. The great object of the maltsmen is to keep the temperature from becoming excessive. This they do by frequent turning. The temperature which they wish to preserve varies from 55° to 62° according to the different modes of malting pursued. At the period of the sweating, the roots of the grain begin to appear, at first like a small white prominence at the bottom of each seed, which soon divides itself into three rootlets, and increases in length with very great rapidity, unless checked by turning the malt. About a day after the sprouting of the roots, the rudiments of the future stem, called *acrospire* by the maltsters, may be seen to lengthen. It rises from the same extremity of the seed with the root, and advancing within the husks, at last issues from the opposite end; but the process of malting is stopped before it has made such progress.

As the acrospire shoots along the grain, the appearance of the kernel, or cotyledon, undergoes a considerable change. The glutinous and mucilaginous matter is taken up and removed, the colour becomes white, and the texture so loose that it crumbles to powder between the fingers. The object of malting is to produce this change; when it is accomplished, which takes place when the acrospire has come nearly to the end of the seed, the process is stopped by drying the malt upon the kiln, at first with a temperature of 90° increased slowly to 140° or higher, according to circumstances. The malt is then cleaned, to separate the rootlets, which are considered as injurious. By this process of malting, barley increases in bulk from two to three per cent. and decreases in weight about twenty per cent., twelve parts of which however is merely water evaporated by the kiln drying. The remaining eight parts of loss consist of extract carried off in the steep water, the roots separated in cleaning, and loss by attrition on the floor and otherwise.

The malt thus prepared is next ground in a mill, and infused in the mash tun with somewhat more than its own bulk of water, of a temperature from 160° to 180°. After a few hours the infusion is drawn off, and more hot water added.

Wort has a brownish yellow colour, a luscious sweet taste, a peculiar smell, and when pure is perfectly transparent. The water of the wort holds in solution a saccharine matter analogous in every respect to sugar— starch, in greater or

* Library of Entertaining Knowledge.

less quality according to the quality of the malt —a small proportion of gluten, and mucilage in considerable quantity. The wort is afterwards boiled with *hops*, which are the pericarps and seeds of the female flower of the *humulus lupulus*, a diœcious plant of the family of *urticea*. The use of the hops is partly to communicate a peculiar flavour, from the essential oil which they contain, partly to neutralize the sweetness of the saccharine matter by the bitter principle which they contain, and partly to counteract the tendency which wort has to run into acidity. The wort is now placed in flat vessels to cool, and when brought down to 52° is then put into a deep vat or fermenting tun. When fermentation takes place, the temperature rises, a scum collects on the surface, and the whole ingredients assume a new action. In order to induce and accelerate this fermentation, a quantity of *yeast* is added, in proportion of about a gallon to every three barrels of wort. In ale wort the rise of temperature is about 15°, in stronger *wash*, for the purpose of distillation, the increase of temperature is sometimes 50°. The fermented liquor is also specifically lighter than the wort, and now contains alcohol in place of the displaced saccharine matter of which it was originally for the most part composed.

Oats *(avena)*. This grain differs in its external appearance from wheat, barley, or rye, especially in the form of the ear. The ear is a panicle formed by the rachis, dividing into numerous branches, the large ones being at the base, while towards the top they gradually decrease, thus forming a conical or tapering figure. While the ear is yet recent the branches are erect; but as the seeds advance towards maturity, and become full and heavy, they assume a dependent form. By this position the air and light has more free access to the ripening grains, while the rain washes off the eggs or larvæ of insects that would otherwise prey upon the young seeds. From these circumstances, as well as from the nature of the plant generally, oats are found to be of such a hardy nature as to thrive in soils and climates where the other grains cannot be raised. Cold and wet climates are not unfavourable to the production of oats; while, on the contrary, extreme heat and drought render this grain husky and tasteless. We accordingly find the oat thriving in great luxuriance in northern climates, while it cannot be cultivated with any success in the southern parts of the temperate zone. Even in the south of England the produce is inferior to that which is obtained in the more northern districts and in Scotland.

There are now no means of ascertaining the period when oats were first introduced into England; indeed some suppose that this grain is indigenous to the country.

Avena Sativa. Of this, the species most com-

93.

a. *b.*

monly cultivated, there are several varieties, as the bearded or long black oat, *a;* the white oat, *b;* the red oat, and the naked or pilcorn.

The best variety of oats produced in Great Britain is unquestionably the *potatoe oat*. Of this kind the first plants were discovered growing accidentally on a heap of manure in company with several potatoe plants, the growth of which was equally accidental; and it is to this circumstance that the distinctive name of this variety is owing. To an occurrence thus purely accidental, and which might well have passed unnoticed, we are indebted for decidedly the best and most profitable variety we possess of this useful grain. It requires to be sown on land in a good state of cultivation, when the grains on ripening will be found large, plump, and firm, often double, and of a quality which insures for the corn a higher price in the market than is given for any other variety. It also yields an abundant produce of straw. Potatoe oats form almost the only kind now cultivated in the north of England and the lowland districts of Scotland.

The seed-time of oats is almost universally in March and April. The grain is scattered broadcast, in the large proportion of from four to six bushels to the acre, the medium produce of which is from forty to fifty bushels.

The nutritive quality of oats is smaller in a given weight than that of any other cereal grains. In oats of the best quality it does not exceed 75 per cent., while that of wheat is 95½ per cent. The very small proportion of saccharine matter ready formed in oats renders it very difficult and unprofitable to convert this grain into malt. Brewers at the present day do not employ oats in the preparation of any kind of beer. In former times, when the public taste was different from what it is at present, a drink called *mum* was manufactured for sale, and in the preparation of this liquid oatmeal was employed. The principal use now made of oats in the southern division of the kingdom is the feeding of horses, for which purpose the grain is admirably adapted; a large quantity of this grain is farther consumed in the fattening of poultry. The deer of Henry VIII. were fed with oats. In the privy purse expenses of this king (published by Mr Nicolas), is the following entry:—"Paied to the keper of

Grenewiche parke for xiiij lode of hey And for vi lode of Oots, for the relief of the dere there, And for the carriage thereof, vj*li.* ij*s.* viii*d.*" Oatmeal, prepared by various processes of cooking, composes at this day a large proportion of the food of the inhabitants of Scotland, and particularly of the better-fed portion of the labouring classes. Oaten cakes, too, are much used in Lancashire.

The wild oat, which is certainly indigenous to this country, is found to be a very troublesome weed. It is said that the seed will remain buried under the soil during a century or more without losing its vegetating power; and that ground which has been broken up, after remaining in grass from time immemorial, has produced the wild oat abundantly.

The Anglo-Saxon monks of the abbey of St Edmund, in the eighth century, ate barley bread, because the income of the establishment would not admit of their feeding twice or thrice a-day on wheaten bread. The English labourers of the southern and midland counties, in the latter part of the eighteenth century, refused to eat bread made of one-third wheat, one-third rye, and one-third barley, saying, that "they had lost their rye-teeth." It would be a curious and not unprofitable inquiry, to trace the progress of the national taste in this particular. It would show that whatever privations the English labourer may now endure, and whatever he has endured for many generations, he has succeeded in rendering the dearest kind of vegetable food the general food of the country; this single circumstance is a security to him against those sufferings from actual famine which were familiar to his fore-elders, and which are still the objects of continual apprehension in those countries where the labourers live upon the cheapest substances. Wages cannot be depressed in such a manner as to deprive the labourer, for any length of time, of the power of maintaining himself upon the kind of food which habit has made necessary to him; and as the ordinary food of the English labourer is not the very cheapest that can be got, it is in his power to have recourse for a while to less expensive articles of subsistence should any temporary scarcity of food, or want of employment, deprive him of his usual fare—an advantage not possessed by his Irish fellow-subjects, to whom the failure of a potatoe crop is a matter not of discomfort merely, but of absolute starvation.

Pierce Plowman, a writer of the time of Edward III., says, that *when the new corn began to be sold*,

> "Woulde no beggar eat bread that in it beanes were,
> But of coket, and clermantyne, or else clene wheate."

This taste, however, was only to be indulged "when the new corn began to be sold;" for then a short season of plenty succeeded to a long period of fasting—the supply of corn was not equalized throughout the year by the provident effects of commercial speculation. The fluctuations in the price of grain, experienced during this period, and which were partly owing to insufficient agricultural skill, were sudden and excessive. On the securing of an abundant harvest in 1317, wheat, the price of which had been so high as 80*s.*, fell immediately to 6*s.* 8*d.* per quarter. The people of those days seem always to have looked for a great abatement in the price of grain on the successful gathering of every harvest; and the inordinate joy of our ancestors at their harvest-home—a joy which is faintly reflected in our own times—proceeded, there is little doubt, from the change which the gathering of the crops produced, from want to abundance, from famine to fullness. That useful class of men, who employ themselves in purchasing from the producers that they may sell again to the consumers, was then unknown in England. Immediately after the harvest, the people bought their corn directly from the farmers at a cheap rate, and, as is usual under such circumstances, were improvident in the use of it, so that the supply fell short before the arrival of the following harvest, and prices advanced out of all proportion.

In a valuation of Colchester, in 1296, almost every family was provided with a small store of barley and oats, usually about a quarter or two of each. Scarcely any wheat is noticed in the inventory, and very little rye. The corn was usually ground at home in a handmill or quern; although wind and water mills were not uncommon. The general use of the latter machines was probably prevented by the compulsory laws by which the tenant was under an obligation to grind his corn at the lord's mill; and, therefore, to evade the tax called *multure*, the labour of the handmill was endured. In Wicliff's translation of the Bible we find a passage in the 24th chapter of St Matthew thus rendered: "Two wymmen schulen (shall) be gryndynge in one querne." Harrison, the historian, two centuries later, says, that his wife ground her malt at home upon her quern. In the present authorized version of the Bible, published more than half a century after Harrison, the word "quern" yields to "mill." By that time, probably, the trades of a miller and a baker were freely exercised; and the lord's mill and the corporation oven had been superseded by the competition growing out of increasing capital and population.

The Reformation and the discovery of America were events that had a considerable influence upon the condition of the great body of the people in England. The one drove away the inmates of the monasteries, from whence the poor were accustomed to receive donations of food; the other, by pouring the precious metals into Eu-

rope, raised the price of provisions. In the latter half of the sixteenth century, wheat was three times as dear, both in England and France, as in the former half. The price of wheat, upon an average of years, varied very little for four centuries before the metallic riches of the New World were brought into Europe; upon an average of years it has varied very little since. The people of the days of Henry VIII. felt the change in the money-value of provisions, although the real value remained the same; and they ascribed the circumstance to the dissolution of the monasteries.

When wheat was fourteen-pence a bushel, it was probably consumed by the people in seasons of plenty, and soon after harvest. During a portion of the year there is little doubt that the English labourers had better food than the French, who, in the fifteenth century, were described by Fortescue thus: "They drynke water, they eate apples, with bred right brown, made of rye." Locke, travelling in France in 1678, says of the peasantry in his journal, "Their ordinary food, rye bread and water." The English always disliked what they emphatically termed "changing the white loaf for the brown." They would have paid little respect to the example of Masinissa, the African general, who is described by Polybius as eating brown bread with a relish at the door of his tent. Their dislike to brown bread in some degree prevented the change which they proverbially dreaded. In the latter part of the sixteenth century, however, this change was pretty general, whatever was the previous condition of the people. Harrison says, speaking of the agricultural population, "As for wheaten bread, they eat it when they can reach unto the price of it, contenting themselves, in the meantime, with bread made of oates or barlie, a poore estate, God wot!" In another place he says, "The bread throughout the land is made of such graine as the soil yieldeth; nevertheless, the gentilitie commonlie provide themselves sufficiently of wheate for their own tables, whilst their household and poore neighbours, in some shires, are inforced to content themselves with rie or barlie." Harrison then goes on to describe the several sorts of bread made in England at his day, viz. manchet, cheat, or wheaten bread; another inferior sort of bread, called ravelled, and lastly, brown bread. Of the latter there were two sorts: "One baked up as it cometh from the mill, so that neither the bran nor the floure are any whit diminished. The other hath no floure left therein at all; and it is not only the worst and weakest of all the other sorts, but also appointed in *old time* for servants, slaves, and the inferior kind of people to feed upon. Hereunto, likewise, because it is drie and brickle in the working, some add a portion of rie-meale, in *our time*, whereby the rough drinesse thereof is somewhat qualified, and then it is named mescelin, that is, bread made of mingled corne." In the household book of Sir Edward Coke, in 1596, we find constant entries of oatmeal for the use of the house, besides "otmell to make the poore folkes porage," and "rie-meall, to make breade for the poore." The household wheaten bread was partly baked in the house and partly taken of the baker. In that year it appears, from the historian Stow, that there was a great fluctuation in the price of corn; and he particularly mentions the price of oatmeal, which would indicate that it was an article of general consumption, as well in a liquid form, as in that of the oat-cakes of the north of England.

In 1626, Charles I., upon an occasion of subjecting the brewers and maltsters to a royal license, declared that the measure was "for the relief of the poorer sort of his people, whose usual bread was barley; and for the restraining of innkeepers and victuallers, who made their ale and beer too strong and heady." The grain to be saved by the weakness of the beer was for the benefit of the consumers of barley-bread.

At the period of the Revolution (1689) wheaten bread formed, in comparison with its present consumption, a small proportion of the food of the people of England. The following estimate of the then produce of the arable land in the kingdom tends to prove this position. This estimate was made by Gregory King, whose statistical calculations have generally been considered entitled to credit.

	Bushels.
Wheat, ...	14,000,000
Rye, ...	10,000,000
Barley, ...	27,000,000
Oats, ...	16,000,000
Pease, ...	7,000,000
Beans, ...	4,000,000
Vetches, ...	1,000,000
In all, . . .	79,000,000

At the commencement of the last century wheaten bread became much more generally used by the labouring classes, a proof that their condition was improved. In 1725, it was even used in poor-houses in the southern counties. The author of "Three Tracts on the Corn Trade," published at the beginning of the reign of George III., says, "It is certain that bread made of wheat is become much more generally the food of the common people since 1689, than it was before that time; but it is still very far from being the food of the people in general." He then enters into a very curious calculation, the results of which are as follow: The whole number of people is 6,000,000, and of those who eat

Wheat, the number is, .	3,750,000
Barley, . . .	739,000
Rye, ...	888,000
Oats, ...	623,000
Total, . . .	6,000,000

This calculation applies only to England and Wales. Of the number consuming wheat, the proportion assigned to the northern counties of York, Westmoreland, Durham, Cumberland, and Northumberland, is only 30,000. Eden, in his History of the Poor, says, "About fifty years ago (this was written in 1797), so small was the quantity of wheat used in the county of Cumberland, that it was only a rich family that used a peck of wheat in the course of the year, and that was used at Christmas. The usual treat for a stranger was a thick oat-cake (called haver-bannock) and butter. An old labourer of eighty-five remarks that when he was a boy he was at Carlisle market with his father, and wishing to indulge himself with a penny loaf made of wheat-flour, he searched for it for some time, but could not procure a piece of wheaten bread at any shop in the town."

At the time of the Revolution, according to the estimate of Gregory King, 14,000,000 bushels of wheat were grown in England. In 1828, according to the estimate of Mr Jacob, in his Tracts on the Corn Trade, 12,500,000 quarters, or 100,000,000 bushels were grown. The population of England at the Revolution was under five millions, so that each person consumed about three bushels annually. The population, at the present time, is under fifteen millions, so that each person consumes about seven bushels annually.

RICE *(oryza sativa)*. This is a panicled grass, bearing, when in ear, a nearer resemblance to barley than to any other of the corn-plants grown in England. The seed grows on separate pedicles springing from the main stalk; each grain is terminated with an awn or beard, and is inclosed in a rough yellow husk, the whole forming a spiked panicle. The stalk is not unlike that of wheat, but the joints are more numerous. The farina of rice is almost entirely composed of starch, having little or no gluten, and being without any ready formed saccharine matter. The outer husk clings with great tenacity to the grain, and is only to be detached from it by passing the rice between a pair of mill-stones, placed at such a distance from each other as shall serve to remove the husk by friction, without crushing the grain. This is besides enveloped by a thin pellicle, which for the most part is rubbed off by trituration in large mortars, with pestles weighing from two to three hundred pounds.

94

There is little reason for doubting that this grain is of Asiatic origin. From the earliest records it has formed the principal, if not the only food of the great mass of the population on the continent and islands of India and throughout the Chinese empire.

Rice is one of the chief productions of Egypt, and constitutes one of the principal sources of wealth to the inhabitants. It grows in the rice fields round Damietta and Rosetta, which are easily irrigated for this purpose by the waters of the Nile. The Egyptians are supposed to have learned the cultivation of rice under the reign of the Caliphs, at which time many useful plants were brought over the Red sea to Egypt, which now grow spontaneously there and enrich the country. Hasselquist thus describes the manner in which he witnessed the separation of the grain from the husk. It is pounded by hollow iron pestles of a cylindrical form, an inch in diameter, lifted up by a wheel worked by oxen. A person sitting between the two pestles pushes forward the rice when the pestles are rising; another sifts, winnows, and lays it under the pestles. In this manner they continue working until it is entirely free from chaff and husks. When it is clean they add a thirtieth part of salt, and pound them together, by which the rice becomes white, which before was gray. After this fining it is passed through a fine sieve to part the salt from the rice, and then it is ready for sale.

The introduction of rice as an object of cultivation in America is of very modern occurrence. The author of a work "On the importance of the British Plantations in America," which was published in London during the year 1701, has recorded, as a circumstance then recent, that "a brigantine from the island of Madagascar happened to put in at Carolina, having a little seed-rice left, which the captain gave to a gentleman of the name of Woodward. From part of this he had a very good crop, but was ignorant for some years how to clean it. It was soon dispersed over the province; and by frequent experiments and observations, they found out ways of producing and manufacturing it to so great perfection, that it is thought to exceed any other in value. The writer of this has seen the said captain in Carolina, where he received a handsome gratuity from the gentlemen of that country, in acknowledgment of the service he had done the province. It is likewise reported, that Mr Dubois, then treasurer of the East India company, did send to that country a small bag of seed-rice some short time after, from whence it is reasonable enough to suppose might come those two sorts of that commodity; the one called red rice, in contradistinction to the white, from the redness of the inner husk or rind of this sort, although they both clean and become white alike."

The swamps of South Carolina, both those which are occasioned by the periodical visits of the tides, and those which are caused by the inland floodings of the rivers, are well suited for the production of rice; and not only is the cultivation accomplished with trifling labour, but the grain proves of a remarkably fine quality, being decidedly larger and handsomer than that of the countries whence the seed was originally derived.

It does not appear that this naturalizing of rice in Carolina and Georgia was ever productive of much effect in regard to the diet of the inhabitants of those provinces. Their consumption of rice was doubtless increased by it, because the abundance and cheapness of an article always influence persons to its use. But wheat and maize continued, as before, to be the bread-corn of the country; and the newly introduced grain was cultivated principally because it furnished an article in constant demand, which might be transmitted to the mother country in return for British manufactured goods.

Had a contrary effect followed upon the introduction of rice into the then British colonies of America, and this grain had become, as in India, the universal food of the inhabitants, it is not probable that their condition would have been in any way ameliorated by the change. In countries where rice forms the chief article of food, dearths are not by any means of uncommon occurrence. A failure of the usual supply of rain, which is followed by evil consequences where other descriptions of grain are raised, is productive of tenfold misery where the chief dependence is upon the crop of rice, which without its due degree of moisture proves wholly unproductive. In such cases there can be found few sources of relief, other objects of cultivation being pursued to only a limited extent, and the means of the people not enabling them to compass the purchase of these scarcer articles of food, even when, through the general abundance, they may be procured at their natural price. Happily for the interests of humanity, dearths are becoming less and less frequent of occurrence, through the better understanding of subjects connected with the production and distribution of commodities.

Some botanists enumerate four species of rice, while others suppose these only varieties of the same grain, occasioned by difference of soil, climate, and culture. These varieties are common rice—early rice, mountain rice, and clammy rice.

Common rice is a marsh plant. If the ground on which it is sown should become dry before the plants arrive at maturity, they wither. It is this variety which grows most strongly; and on lands peculiarly adapted for it the culture is probably as advantageous as can well be pursued.

Early rice, like the other, is a marsh plant, but it does not grow to the same size. It comes much sooner to maturity; for while common rice is never ripe in less than six months from the time of ploughing, this variety, if placed in favourable situations, requires only four months for arriving at perfection.

Mountain rice thrives on the slopes of hills and in other situations where it can receive humidity only occasionally. Dr Wallich, sent to London a few years ago some specimens of rice grown on the cold mountains of Nepaul. These seeds were furnished to him by the resident of the East India Company in that district, and were recognised by the Doctor as mountain rice. The degree of cold which this plant is qualified to bear is very great. According to the information collected on the subject by Dr Wallich, the cultivators consider their crop quite safe if the growth of the plants is advanced five or six inches above the surface at the time the winter snows cover the ground. It is probable that the slow melting of the snow is beneficial to the growth of the plant, which advances with great vigour on the return of spring.

A knowledge of these circumstances might have led to the opinion that this variety of rice could be naturalized in England, if the attempt had not already been fairly made by one well qualified for conducting the experiment. Samples of six different sorts of mountain rice which had been procured by Sir John Murray from the neighbourhood of Serinagur at the foot of Mount Imaus, were, on the occasion alluded to, presented by the Board of Agriculture to Sir Joseph Banks, who planted each kind in a separate bed, in a sheltered spot with a south aspect, in his garden at Spring Grove. The grains, which were sown very thin on the 21st of May, speedily sprang up, and the plants tillered so much that the beds put on the appearance of compact, dense masses of vegetation; each plant having from ten to twenty off-sets. Although the blades grew vigorously, attaining in a short time to the length of two feet, there was never any symptom of a rising stem, and if the ground was not watered, either by rain or artificially every three or four days, the plants began to assume a sickly hue. In this manner vegetation proceeded, without the smallest symptom of their perfecting themselves by fructification, when the plants were suddenly destroyed by an early night frost in September. Some of the plants, which had been transferred to pots and placed in the hothouse at an early period of their growth, soon died; while others, which were sown originally in a hot-house, produced ears and flowered, but the blossoms dropped without perfecting any seed.

The conclusion to which Sir Joseph Banks arrived from these experiments was unfavourable to the cultivation of rice in this country as a

grain-bearing plant; but he was led to consider, from the great quantity of its blades, that it would afford excellent green-meat for cattle.

Clammy rice appears to be endowed with the peculiar property of growing both on wet and on dry lands: the period occupied by its growth is intermediate between those of the common and early varieties.

Rice seed is sown in Carolina in rows, in the bottom of trenches, which are about eighteen inches apart, reckoning from the centres of the trenches. The sowing is generally performed by negro women, who do not scatter the seed, but put it carefully into the ground with the hand, so as to preserve the perfect straightness of the line. The sowing is for the most part completed by the middle of March. The water, which until then has been kept back by means of flood-gates, is at this time permitted to overflow the ground to the depth of several inches, and things remain in this state for some days,—generally about a week. The germination of the seed is promoted by this flooding, and the water being then drawn from the surface of the land, the plants sprout, rising in about four weeks to the height of three or four inches. At this time the flood-gates are again opened, the fields are once more overflowed, and remain in that state during about sixteen days; one good effect of this second flooding being the destruction of the grass and weeds which may have sprouted at the same time with the rice. The land is allowed after this to remain without further irrigation until the middle of July, being repeatedly hoed during the interval, as well to remove any weeds at the moment of their appearance, as to loosen the soil about the roots of the rice, adopting thus in all its principal parts the drill system of husbandry. At the time last mentioned, water is again admitted, and remains covering the surface until the grain is actually ripened.

The rice harvest in the United States usually commences at the end of August, and extends through the entire month of September, or even somewhat later. The reaping is performed with a sickle by male negroes, and these are followed by females, who collect the rice into bundles.

This cultivation is found to be extremely unhealthy to the negroes employed in its prosecution. The alternate flooding and drying of the land in so hot a climate, where natural evaporation proceeds with great rapidity, must necessarily be prejudicial to health. To avoid exposure to this unwholesome atmosphere, the whole white population abandon the low grounds to the care of negro cultivators. The mortality thus occasioned among the labourers in rice districts is so great, that while the general increase of population in the States exceeds by far that realized in the older settled countries of Europe, fresh supplies of negro slaves must continually be brought, to repair the waste of life, from the more northern slave states of the Union.

The cultivation of rice is very extensively and successfully carried on in the rich meadows of Lombardy, which can be irrigated by the waters of the Po. The meadows chosen for the purpose are perfectly flat. After the seed is sown, the water is turned on and allowed to cover the surface to the depth of several inches during the whole course of its growth, and until the rice is ripe. Three crops are taken successively from the ground in this manner without manuring; but the soil is then so far exhausted, that it must be manured and planted for a time with other crops, before another succession of rice harvests can be drawn from it.

This system of agriculture proves the most profitable to the cultivator of any that is carried on in Lombardy; but the same unwholesome effect is experienced there as in Carolina; and the government at Milan finds it expedient to restrict the cultivation within a certain limit, beyond which the production of rice is not allowed. The quantity of seed usually sown is three bushels to the acre, and the average produce from the same measure of land, is commonly about six quarters.

In the province of Valencia in Spain, the method of rice cultivation is very similar to that pursued in Lombardy. The water remains on the ground even during the operations of harvest, and the reapers are obliged to wade up to their knees in order to cut the grain, other persons following to receive the sheaves as they are cut, and to convey them to some dry place, where the grain is detached from the ear by the treading of mules.

The hollows between Columbo and Candy, in the island of Ceylon, are devoted to the production of rice. The fields on which it is sown are artificially formed into a regular succession of terraces, one above another, so that the water of irrigation may be made to flow from a higher to a lower level, the plants being in different stages of their growth. In some cases the water is led for a mile, or even two miles along the side of a mountain, and is then discharged over the highest terrace, and thence downward in succession to the lowest, according as moisture may be required by each. Bishop Heber, for whom the charms of nature, whether in a wild or cultivated state, were never displayed in vain, remarks, on visiting this district, that "the verdure of the young rice is particularly fine, and the fields are really a beautiful sight, when surrounded by and contrasted with the magnificent mountain scenery."

Rice is extensively cultivated throughout the Chinese empire, and in consequence of the value of all such products of the earth, to a people so numerous, much care is taken in its culture.

The Chinese method of raising rice is thus detailed by Duhamel:

"To hasten the germination of the seed-rice it is placed in baskets and immersed during some days in standing water.

"When the ground is so thoroughly soaked that the surface is like soft mud, it is ploughed with a buffalo, yoked to a very simple plough, without wheels, and having only one handle. The clods are after this broken down by means of a rude kind of hurdle, drawn also by a buffalo, the driver sitting upon the hurdle to increase the weight. The ground is cleared very carefully of all stones, and whatever weeds may be found are diligently removed with their roots. The land is then partly covered with water, and smoothed by a harrow which has several rows of great iron teeth.

"The seed-rice, when it has once sprouted, is known to be good; grains not in this situation are rejected, and the remainder is sown by hand very thickly and as equally as possible upon a part only of the land, which is thus used as a sort of nursery for the remainder. The land having at this time upon it just as much water as will barely cover it, the points of the plants appear above the surface one day after the seed has been sown.

"In a short time, when the plants have acquired a little strength, they are sprinkled over with lime-water, the object of this being the destruction of insects. For this purpose a small basket with a long handle is used, and this being filled by immersion in the lime-water, the fluid runs through in divided portions over the plants. This practice is found to be so efficacious, that the Chinese are said to hold its first inventor in the highest veneration.

"Towards April, when the plants cover thickly the ground that has been sown, the greatest part of them are pulled up with their roots and planted in tufts, pretty far asunder in a quincunx form, in fields prepared for their reception. A serene day is chosen for this operation, which must be performed quickly, so that the plants are as short a time as possible out of the ground.

"After this, water is admitted to overflow the rice, the grounds being, for this purpose, always situated near a rivulet, pond, or great pool of water, from which they are separated only by a bank which may readily be cut. It sometimes happens, however, that the water is below the level of the fields, in which case the necessary quantity is conveyed in buckets, which are worked chiefly by the aid of ropes,—a most laborious occupation.

"Though a man cannot step in these rice-grounds without sinking up to his knees, the Chinese weed them three times during the summer, and that so carefully, that every weed they can find is pulled up by the roots.

"When the rice is ripe, which is known in the same manner as wheat, by its turning yellow, it is cut down with a sickle, made into sheaves, and conveyed into a barn, where it is threshed with flails very similar to those used among ourselves." The husk and inner pellicle are removed by beating and trituration, pretty much in the same manner as has already been described.

The Chinese plant their seed-rice at regular intervals, and carefully weed and raise up the soil between the plants; thus they have practised for ages the system of drilling and hoeing grain, which has been but lately introduced into the husbandry of Europe. The method of cultivating rice in Hindostan very much resembles that of the Chinese.

In both India and China rice forms the subsistence of the native population, more exclusively and to a greater extent than can perhaps be said of any other vegetable substance in any known region of the globe. In the countries just mentioned, as well as in those districts of Africa where it is used indiscriminately with maize, rice undergoes but little culinary preparation, being, for the most part, simply boiled with water, and eaten either by itself, or accompanied by some stimulating or oily substance. In countries, on the other hand, where it is employed only as an auxiliary article of food, rice is subjected to a greater degree of preparation for the table, and except when used to thicken broths, is seldom presented, unless after concoction with eggs, and milk, and sugar, which cover the natural insipidity of the grain.

When our grain crops happen to be deficient in this country, it has been proposed to mix a quantity of rice with wheat, or rye flour for making bread. This has been tried with some success, though it is alleged that such bread soon becomes dry and unpleasant.

The method is as follows:—First reduce the rice to powder in a mill, or throw the whole grains into water at nearly a boiling heat, and allow them to soak during some hours. Then drain off the water, and when the rice shall have become sufficiently dry, beat it in a mortar, and pass the powder through a fine sieve. This flour must next be placed in a kneading-trough, and moistened in the necessary degree with water rendered glutinous by boiling whole rice in it for some time; add salt, and the proper quantity of leaven or yeast, and knead the whole intimately together. The dough must then be covered with warm cloths and left to rise. During this fermentative process, the dough, which was of a pretty firm consistence, will become so soft as not to be capable of being formed into loaves. It is, therefore, placed in the requisite quantities as in forms, and these being covered with larger leaves, or with sheets of paper, are introduced

into the oven, the heat of which speedily sets the dough sufficiently, so that the tins being reversed, their contents are turned out upon the leaves or paper. The bread, when perfectly baked, will be of a fine yellow colour, similar to that imparted to flour by the yolks of eggs, and when new is said to be sufficiently agreeable.

The Chinese manufacture a sort of wine from rice, said to be similar to Spanish white wine.

Duhamel describes a method of mixing rice with malted barley, for the manufacture of beer. Four parts of crushed rice steeped in an equivalent weight of water, are added to one part of malt, the ready formed saccharine matter of the barley malt appears to have the singular property of speedily converting the fecula of unmalted corn into a kind of soluble matter which has the fermentative properties of sugar. If malt and rice flour, diluted so as to have a pasty consistence, be mixed and mashed together, and then left during three or four hours, the mixture will present the appearance of a liquid which is slightly saccharine to the taste, and having a sediment at the bottom of the vessel, which is found, on examination, to be composed of only the husks of barley and rice. M. Dubrunfaut used for the purpose rice from which the husk had not been removed previous to its being crushed, and which in this state is known by the name of *paddy* or more properly *paddee*.

Zea Mayz *(maize or Indian corn)* is a plant indigenous to America, having been found under partial cultivation by the Indians on the discovery of the New World. It is extensively cultivated both in North and South America, and forms an article of food as important to the inhabitants of those regions, as rice does in the eastern countries. There is only one ascertained species of maize, although several varieties seem to arise in consequence of differences of soil, culture, and climate.

The plant consists of a strong jointed stalk (see Plate VI., figs. 1, 2.), provided with large alternate leaves, almost like flags, springing from every joint. The top produces a bunch of male flowers, of various colours, which is called the *tassel*. Each plant bears, likewise, one or more spikes or *ears*, seldom so few as one, and rarely more than four or five, the most usual number being three: as many as seven have been seen occasionally on one stalk. These ears proceed from the stalk at various distances from the ground, and are closely enveloped by several thin leaves, forming a sheath, which is called the *husk*. The ears consist of a cylindrical substance, of the nature of pith, which is called the *cobb*, over the entire surface of which the seeds are ranged, and fixed in eight or more straight rows, each row having generally as many as thirty or more seeds. The eyes or germs of the seeds are in nearly radial lines from the centre of the cylinder; from these eyes proceed individual filaments of a silky appearance, and of a bright green colour; the aggregate of these hang out from the point of the husk, in a thick cluster, and in this state are called the *silk*. It is the office of these filaments, which are the stigmata, to receive the farina, which drops from the flowers on the top, or tassel, and without which the ears would produce no seed—a fact which has been established by cutting off the top previous to the development of its flowers, when the ears proved wholly barren. So soon as their office has been thus performed, both the tassel and the silk dry up, and put on a withered appearance.

The grains of maize are of different colours, the prevailing hue being yellow, of various shades, sometimes approaching to white, and at other times deepening to red. Some are of a deep chocolate colour, others greenish or olive-coloured, and even the same ears will sometimes contain grains of different colours.

Maize is said to contain no gluten, and little if any ready-formed saccharine matter, whence it has been asserted to have but a very small nutritive power; on the other hand, it is seen that domestic animals which are fed with it very speedily become fat, their flesh being at the same time remarkably firm. Horses which consume this corn are enabled to perform their full portion of labour, are exceedingly hardy, and require but little care; and the common people of countries where Indian corn forms the ordinary food, are for the most part strong and hardy races. The produce of maize, on a given extent of cultivation, is greater than that of any other grain; and the proportional return for the quantity of seed committed to the ground is equally advantageous.

American Indian Corn is the largest known variety of maize. It is found growing wild in many of the West Indian islands, as well as in the central parts of America; and there can be no doubt of its being a native of those regions. In favourable situations it has a very considerable growth, attaining to the height of from seven to ten feet; in some cases it has acquired the gigantic height of fourteen feet, without in any way impairing its productive power. Its spike, or ear, is eight or ten inches in length, and five or six inches in circumference. The plant generally sends out one, two, or more suckers from the bottom of the stalk; but these it is advisable to remove, not only as they draw away part of the nourishment which should go to support the main stalk, but because the ears which the suckers bear ripen at later periods than the others, and the harvest could not all be simultaneously secured in the properest state of maturity.

This variety will rarely come to maturity in northern climates, and could never be securely

relied on for a crop in any part of Europe. In the Mexican states, where this grain is known by the name of *Tlaouili*, there are few parts of either the lower districts—*tierra caliente*—or of the table-land, whereon it is not successfully cultivated. In the former districts its growth is naturally more luxuriant than in the latter; but even at an elevation of six or seven thousand feet above the level of the sea, its productiveness is calculated to excite wonder, if not to provoke incredulity on the part of European agriculturists. Some particularly favoured spots have been known to yield an increase of eight hundred for one; and it is perfectly common in situations where artificial irrigation is practised, to gather from three hundred and fifty to four hundred measures of grain for every one measure that has been sown. In other places, where reliance is placed only on the natural supply of moisture to the soil from the periodical rains, such an abundant return is not expected; but even then, and in the least fertile spots, it is rare for the cultivator to realize less than from forty to sixty bushels for each one sown.

The system of husbandry employed is closely analogous to Tull's horse-hoeing plan. The seed is sown, from three to five grains together, at regular intervals of three feet, in rows sufficiently far apart to admit of the passage of a small plough between them, for the purposes of loosening the soil around the roots, and of removing the weeds. The use of manure is altogether unknown in Mexican maize husbandry.

Humboldt states, that in some warm and humid regions of Mexico three harvests of maize may be annually gathered, but that it is not usual to take more than one. The seed-time is from the middle of June to near the end of August. A great part of the internal commerce of Mexico consists in the transmission of this grain, the price of which varies considerably in not very distant stations, owing to the imperfect state of the roads and the insufficient means of transport. As an instance of this, Humboldt mentions the fact, that during his stay in the intendancy of Guanaxuato, the fanega (five bushels) of maize cost at Salamanca nine, at Queretaro twelve, and San Luiz Potosi twenty-two, livres. For want of a proper diffusion of commercial capital, the Mexican public is without the advantage of magazines for storing corn, and for preventing, by that means, great fluctuations in price. It is a fortunate circumstance, and one which should be mentioned as adding very materially to the natural value of maize in warm climates, that it will remain in store uninjured for periods varying from three to five years, according to the mean temperature of the district.

This kind of corn is generally planted in the United States of America about the middle of May, so as to avoid the mischance of its experiencing frost after it is once out of the ground. The Indians who inhabited the country previously to the formation of any settlement upon its shores by Europeans, having no calendar or other means of calculating the efflux of time, were guided by certain natural indications in their choice of periods for agricultural operations. The time for their sowing of maize was governed by the budding of some particular tree, and by the visits of a certain fish to their waters—both which events observation had proved to be such regular indicators of the season, as fully to warrant the faith which was placed on their recurrence. These simple and untaught people discovered and practised a method of preserving their grain after harvest, which afforded a certain protection against the ravages of insects, and which might be advantageously adopted in other situations, and in climates where this evil is very prevalent. Their method was to separate the corn from the cobb as soon as the harvest was finished; to dry it thoroughly by exposure to the sun, and to a current of air; and then to deposit it in holes dug out of the earth in dry situations, lining these holes with mats of dried grass, and covering them with earth, so as completely to prevent the access of air.

With the exception of artificial irrigation, to which recourse is not had in the United States, the method of sowing and managing maize is there singularly analogous to that pursued in Mexico. The proportionate produce, from a given quantity of seed, or a certain breadth of land, is smaller, however, than that realized in Mexico, although the practice of manuring is universally followed. As compared with the yielding of other kinds of grain, maize cultivation is, nevertheless, highly productive in the United States. In Pennsylvania, where the average crop of wheat does not exceed from fourteen to seventeen bushels, that of maize amounts to from twenty to thirty bushels to the acre. A writer in the Monthly American Journal of Geology and Natural Science, considers that maize produces the heaviest crops near the northern limits of its range. The American farmers find this advantage to attend the partial culture of maize upon their farms, that the time of harvesting is some weeks later than that of wheat, and that, consequently, the general operations of the harvest may be conducted without great bustle and temporary advance of wages, to be followed by a season of inaction and consequently of idleness to the labourer—evils which are commonly experienced in England.

The second variety of maize has white grains. This kind, which is cultivated in Spain, Portugal, and Lombardy, is altogether a smaller plant than the variety just described, seldom exceeding six or seven feet in height; the leaves are narrower, and the tops hang downwards. The ears

or spikes are not more than six or seven inches long. The French, among whom this grain is partially cultivated, have given to it the name of Blé de Turquie, doubtless because their seed was originally obtained from that country.

Except in unusually favourable seasons, the two varieties hitherto described will not come to maturity in England, although they are sometimes sown as a curiosity in warm spots in gardens.

The third variety has both yellow and white seeds. It is even smaller than the last mentioned, seldom rising to a greater height than four feet. The ears do not often exceed four or five inches in length. In ordinary seasons it will ripen its grains perfectly in England; and one reason why it has been presumed that its cultivation would prove advantageous to this country, is the shortness of time required for its growth, whereby the late frosts to which we are sometimes liable in spring, and the early frosts of autumn, would be alike avoided. This particular variety is cultivated in some of the middle regions of the European continent, as well as in some parts of North America, from which latter country it is understood to have its origin. It is also partially cultivated in Germany, not as a bread-corn, but that it may be malted and used in the preparation of a kind of beer, or made to yield an ardent spirit. The use chiefly made of it, however, is that of fattening swine and poultry.

In the cultivation of Indian corn in northern climates, it is proper to make choice of warm spots, and particularly to avoid shady situations. In order to admit the sun as much as possible to the plants, and probably also with the view of affording more nutriment to the grain, it is usual to remove the blades, together with the top and tassel, as soon as its office of dropping its fecundating farina upon the ears has been fully accomplished. This process is very easy of performance. When the blades and tops are perfectly dry they are stacked and thatched, and form an excellent substitute for hay and chaff in the spring, both for cattle and horses, as well as for sheep, all these animals being attracted by its sweetness.

It may generally be known when the corn is ripened, by the dry and white appearance put on by the husk; a more intimate inspection is, however, accomplished without difficulty. The ears must then be plucked off, together with the husks, and conveyed at once in carts to the barn. In America, the stalks are usually left standing for some time longer. Being then cut near to the ground, tied up into bundles, and stacked in a dry place, they will prove useful as food for horned cattle, which, from the saccharine quality of the plants, will thrive upon them.

The ears are preserved in bins or cages, which are called corn-cribs, sometimes with the husk, and at other times without it; and it is not considered good farming to shell the corn before it is required to be sent to market. This operation of shelling is very easily performed. The only implement required for the purpose is a piece of iron in shape like a sword-blade, the edge of which is not sharp, and this iron being fixed across the top of a tub in which the shelled grains are to be collected, the ear is taken in both hands, and scraped lengthwise smartly across the edge of the iron until all the grains are removed. In this manner, it is said, an industrious man will shell from twenty to twenty-five bushels of corn in the course of the day. The cobb which remains makes a very tolerable quick-burning fuel, and thus no part of the plant proves altogether without use.

The grain forms one-half the measure of the ear, that is to say, two bushels of ears will yield one bushel of shelled corn. So correct is this estimate found to be, that in the markets of the United States, where Indian corn is sold both shelled and with the cobb, two bushels of the latter are taken without question by the purchaser, as being equal to one bushel of shelled grain.

Captain Lyon, in the narrative of his travels in Mexico, has given an amusing account of the mode of preparing *tortillas*, a species of cake made with the crushed grains of maize, which is eaten hot at the meals of all classes of people, the more wealthy using the cakes in the way we are accustomed to use wheaten bread,—as an auxiliary to more nourishing aliments—and the peasants being fain to enjoy them as a substantive food, seasoning them, when they have the opportunity, by the addition of chilies stewed into a kind of sauce, wherein the tortillas are dipped. Simple as the art may appear of thus making an unleavened cake with moistened flour, some persons are found to acquire a greater degree of expertness in it than others; and so great is the necessity for their preparation, and the desire of having them well concocted, that according to Captain Lyon, "in the houses of respectable people, a woman, called from her office Tortillera, is kept for the express purpose; and it sounds very oddly to the ear of a stranger during meal-times, to hear the rapid patting and clapping which goes forward in the cooking-place, until all demands are satisfied."

Dr Franklin thus details the various uses to which maize may be applied:

"It is remarked in North America, that the English farmers, when they first arrive there, finding a soil and climate proper for the husbandry they have been accustomed to, and particularly suitable for raising wheat, despise and neglect the culture of maize or Indian corn; but observing the advantage it affords their neighbours, the older inhabitants, they by degrees get

more and more into the practice of raising it; and the face of the country shows from time to time that the culture of that grain goes on visibly augmenting.

"The inducements are the many different ways in which it may be prepared so as to afford a wholesome and pleasing nourishment to men and other animals. First, the family can begin to make use of it before the time of full harvest; for the tender green ears, stripped of their leaves, and roasted by a quick fire till the grain is brown, and eaten with a little salt or butter, are a delicacy. Secondly, when the grain is riper and harder, the ears, boiled in their leaves and eaten with butter, are also good and agreeable food. The tender green grains dried may be kept all the year, and mixed with green *haricots* (kidney beans), also dried, make at any time a pleasing dish, being first soaked some hours in water, and then boiled. When the grain is ripe and hard there are also several ways of using it. One is to soak it all night in a *lessive* or lye, and then pound it in a large wooden mortar with a wooden pestle; the skin of each grain is by that means skinned off, and the farinaceous part left whole, which being boiled swells into a white soft pulp, and eaten with milk, or with butter and sugar, is delicious. The dry grain is also sometimes ground loosely, so as to be broken into pieces of the size of rice, and being winnowed to separate the bran, it is then boiled and eaten with turkeys or other fowls, as rice. Ground into a finer meal, they make of it by boiling a hasty pudding or *bouilli*, to be eaten with milk, or with butter and sugar; this resembles what the Italians call *polenta*. They make of the same meal, with water and salt, a hasty cake, which being stuck against a hoe or other flat iron, is placed erect before the fire, and so baked to be used as bread. Broth is also agreeably thickened with the same meal. They also parch it in this manner. An iron pot is filled with sand, and set on the fire till the sand is very hot. Two or three pounds of the grain are then thrown in, and well mixed with the sand by stirring. Each grain bursts and throws out a white substance of twice its bigness. The sand is separated by a wire sieve, and returned into the pot to be again heated and repeat the operation with fresh grain. That which is parched is pounded to a powder in mortars. This being sifted will keep long for use. An Indian will travel far and subsist long on a small bag of it, taking only six or eight ounces of it per day mixed with water. The flour of maize, mixed with that of wheat, makes excellent bread, sweeter and more agreeable than that of wheat alone. To feed horses, it is good to soak the grain twelve hours, they mash it easier with their teeth, and it yields them more nourishment. The leaves stripped off the stalks after the grain is ripe, tied up in bundles when dry, are excellent forage for horses, cows, &c. The stalks, pressed like sugar-cane, yield a sweet juice, which being fermented and distilled yields an excellent spirit; boiled without fermentation, it affords a pleasant syrup. In Mexico, fields are sown with it thick, that multitudes of small stalks may arise, which being cut from time to time, like asparagus, are served in desserts, and their sweet juice extracted in the mouth by chewing them. The meal wetted is excellent food for young chickens, and the old grain for grown fowls."

In addition to the many uses enumerated by Franklin in the foregoing account, Humboldt acquaints us that the Mexican Indians, previous to the conquest of their country, were accustomed not only to express the sweet juice from maize-stalks for the purpose of fermenting it into an intoxicating liquor, but that they boiled down this juice to the consistence of syrup; giving it likewise as his opinion that they were able even to make sugar from this inspissated juice. In confirmation of this opinion, he recites a letter written by Cortez, who in describing to the Emperor Charles V. the various productions in both a natural and manufactured state which he found in the new country, asserts, that among these were seen "honey of bees and wax, honey from the stalks of maize, which are as sweet as sugar-cane, and honey from a shrub which the people call maguey. The natives make sugar from these plants, and this sugar they also sell." There is no question that the productions here enumerated will yield saccharine matter; but crystallized sugar, properly so called, is a different preparation, and, from our present knowledge, it is difficult to believe that any such substance could have been so prepared.

The Indians, at the period above alluded to, evinced considerable skill in the preparation of fermented liquors, which is by no means lost by the Mexicans of the present day. "A chemist," says Humboldt, "would have some difficulty in preparing the innumerable variety of spirituous, acid, or saccharine beverages which the Indians display a peculiar address in making, by infusing the grain of maize, in which the saccharine matter begins to develope itself by germination. These beverages, generally known by the name of *chicha*, have some of them a resemblance to beer, and others to cyder." The spirituous liquor called *pulque de mahis* or *tlaouili*, which is prepared from juice expressed from the stalk of the maize, forms, in some parts of the republic, a very important article of commerce.

Sitaria itallica—*Italian Millet*, (fig. *a*.) *Millet*, is a species of grass, which in certain countries where the soil is light and arid, is cultivated in place of corn. The seed is extremely small but this is made up by the number borne

95.

a. Italian Millet. b. Pannicled Millet.

by each ear or pannicle. From this great number of grains, amounting to a thousand (*mille*,) the name of the plant is supposed to be derived.

The Italian millet is without doubt a native of India, where it is called *congue*. The stalk is a jointed reed, with a long, broad, amplexial leaf, proceeding from each joint. It is in height about three or four feet, and terminates in a compact spike of an oval form, about nine inches long. The numerous grains adhere but slightly to the husks, and are easily shaken out; the seeds are of various colours. The Italians make a sort of coarse brown bread from the flour of these seeds; but the principal use of them is for feeding poultry. The leaves and stalks are used as fodder for cattle, and are also made into brushes. The German variety of millet, *Sitaria Germanica*, is similar to the Italian, but rather more diminutive.

Sorghum vulgare, or *pannicled millet*, (fig. *b*.) goes under different names in the different countries where it is cultivated. In India it is called *jovaree;* in Egypt and Nubia *dhourra;* while in our West Indian colonies it has received the name of *Guinea corn*, either because the seed was first conveyed thither from the western coast of Africa, or, as some persons have affirmed, because of its extensive use in feeding the African negroes throughout those colonies. The height to which this plant attains varies according to the soil and culture. In Egypt its growth seldom exceeds five or six feet, while Burckhardt speaks of the stalks of dhourra as being sixteen or twenty feet long. The leaves are thirty inches long, and two inches wide in the broadest part. The flowers, when they first come out in large panicles at the top of the stalk, resemble the male spikes of the maize plant. These flowers are succeeded by roundish seeds, the colour of which is, in some cases, a milky white, with a black umbilical dot; in others the seeds are red, but in both cases they are wrapped round with the chaff, and are better protected from feathered depredators than other kinds of millet.

This grain was introduced into cultivation in Switzerland about the middle of the last century by M. Tschiffeli, who received about a spoonful of the seed from Dr Schreber. M. Tschiffeli published an account of his method of cultivation in the Transactions of the Berne Society; some extracts from which paper will suffice to show the capabilities of this grain when cultivated in northern latitudes. Among the advantages which it offers are stated, its adaptation to all sorts of soils, the small quantity of manure which it requires, the trifling amount of labour for which it calls, and the small degree of exhaustion which it occasions to the soil in comparison with the largeness of the return which it yields.

M. Tschiffeli sowed his first seed in the month of May, on a gravelly soil exposed to the north wind, and which the year before had borne a very indifferent crop of bigg. The seed was spread very thin, and to this circumstance he attributed the fact that the stalks rose to the height of eight feet and upwards. The ears were above ten inches long, and but for an inopportune shower of hail which destroyed half the seed, the spoonful would probably have been multiplied into a peck of grains. In May of the following year, about a quart of seed was sown upon a piece of ground twenty paces long and half as broad, which space, it was soon apparent, was far too circumscribed for the quantity of seed. The stalks came up very close, and were interwoven with each other, reaching scarcely to the height of five feet; and the ears were much smaller than those of the preceding year. The produce, however, was seven pecks, or equivalent to fifty-six for one. In the next year, thirty square rods of land were sowed with half a peck of the seed. Here, again, the millet came up far too thick, being almost as much crowded from its greater tillering, as it was in the preceding year; notwithstanding which, the produce was so great, that twenty bushels were harvested, being a return of one hundred and sixty for one, and at the rate of more than one hundred bushels to the acre. M. Tschiffeli was of opinion that ten pounds of seed would prove an ample allowance for an acre of ground, and that greater space being thus allowed for the individual plants, the proportion between the quantities sown and harvested would be still more favourable. It does not appear that millet has ever been subjected to the system of drill husbandry, although the results here given seem to point out that system as being peculiarly applicable to its cultivation.

Sorghum is cultivated largely in some parts of China and in Cochin China. In England the autumn is rarely sufficiently dry and warm for ripening its seeds, otherwise the plant might prove useful in some poor and light soils, the produce of which is ordinarily insufficient to repay the greater expense attendant upon the cultivation of other grain. Sorghum was raised in this country as a rare plant, in the garden of John Gerarde, as early as 1596.

The golden-coloured millet seeds seen in our grocers' shops are the produce of the *sorghum saccharatum*, or yellow-seeded millet. Use is made of these in a similar manner with rice, for the preparation of puddings.

This variety is likewise a native of India; it is cultivated largely in China and Cochin China; and has been introduced into the island of Jamaica. Philip Miller reared it in his garden in 1759.

In warm climates millet is usually sown in May and June, and perfects its seeds within four months. The plant is not subject to blight, nor is it easily injured by either drought or rain. The only care required in its cultivation is to allow sufficient space for the tillering of the plants, and to weed and hoe the intervals during the early part of the growth; after which it will overtop and smother all weeds.

When millet is ripe, the panicles are cut off near to the top of the stalk, and collected in sacks or baskets. They are then laid up in heaps, and carefully covered during five or six days; after which they are spread on the barn floor, and the grain is threshed out in the ordinary manner with a flail. The more primitive method of treading out the grain by means of oxen is resorted to in some parts of India.

If millet is not perfectly dry when deposited in the granary, it will soon be spoiled; but, on the other hand, if this precaution be properly taken, there is no grain that will keep longer or better. The weevil will not touch it, and although it is doubtless the better for being turned over occasionally, that process, so indispensable with other grain, may be omitted here without producing any serious injury. In addition to the use made of the stalks as fodder, the Nubians employ them in the construction of temporary huts.

In the barren districts of Bornou, a species of millet is produced, which is called by the inhabitants *gussub*, and upon which both men and animals are almost exclusively fed. By the poorer class it is frequently eaten, simply parched, or even without any culinary preparation. Other persons crush and then steep the seeds in water previous to eating them, and some few, who are the epicures of the land, clear the grain from the husk, pound it, and make it up into a light paste with melted fat: this favourite dish is called *kaddel*. The Nubians prepare a fermented liquor from dhourra which they call *bouzah*.

The Grasses. As the various kinds of corn are of the utmost importance as the food of man, so the grasses are no less essential to the maintenance of herbivorous animals. The grasses form a numerous family, and grow abundantly in our pastures and meadows. Several turfs, only six inches in diameter, and taken from various localities in England, were examined by Mr Curtis, and found to contain from six to ten distinct species of the grasses. Of British grasses no less than twenty-five families, or distinct genera, have been classified, and many of these families contain from twelve to eighteen species. The different kinds of grasses are adapted to different localities; some are found to flourish in dry and arid soils, others in rich meadows, and not a few in marshes and moist situations, and thus we have hill and dale clothed with their appropriate verdure. We shall here point out a few of the most important of this family of vegetables.

Meadow Fox-tail Grass (alopecurus pratensis). This grass is distinguished by the largeness of its foliage, and by its producing a soft spike on a long stalk early in May. The meadow cat's-tail grass, or Timothy grass, produces a spike somewhat similar; but it is rougher to the touch, and flowers much later in the summer. It is a very productive grass, shoots very rapidly after mowing, and yields a very plentiful aftermath. This grass grows naturally in a moist soil, and hence it is well adapted to improve very wet ground which has been so far drained of its superfluous moisture. Its seeds are easily collected; but in certain seasons they are very apt to be destroyed by a minute larva, or maggot, of an orange colour, which feeds on the germ.

96.

a Meadow Fox-tail Grass. *b* Sweet-scented vernal Grass.

Sweet-scented vernal Grass (anthoxanthum odoratum). This is also an early-growing grass. It grows readily in all soils and situations, in bogs, in woods where there is little underwood, in rich meadows, and in dry pastures. It is not so productive as some of the other grasses; yet cattle are particularly fond of it. It is the only one of the grasses which is odoriferous. The agreeable scent of new made hay arises entirely from this grass, hence its name of sweet-scented. The green leaves, when slightly compressed or bruised, readily impart this perfume to the fingers, by which means the foliage may be known. It produces fewer seeds than most of the other grasses; and in certain localities, and especially in dry seasons, the leaves are liable to blight, by which they are changed to a yellow hue.

Smooth-stalked meadow Grass (poa pratensis).

97.

Smooth-stalked meadow Grass.

From a creeping root the foliage of this grass begins to shoot and to assume a beautiful verdure very early in spring. The seeds are borne on a panicle of a light and graceful structure. This grass delights in a rather dry situation, and hence it keeps green in long-continued droughts better than the other grasses, yet it will also thrive in a moist locality. It is seen growing on the top of a dry wall, and also flourishing in a wet meadow. It only flowers once a-year, while some of the other grasses are running to seed very frequently; from this circumstance it is well adapted for lawns, where smoothness and uniformity of appearance are desired. In dry soils this grass is apt to fall off in the quantity of foliage; and on the whole, is not reckoned a very productive one to the agriculturist.

Rough-stalked meadow Grass (poa trivialis). In appearance this grass is very like the preceding, yet there are some marked distinctions. The *poa pratensis* has a smooth stalk, the *trivialis* a rough one, which is very perceptible when the latter is drawn across the fingers, and which arises from a number of little sharp setæ or points, placed on the leaf. The trivialis has a long-pointed membrane at the base of the leaf; the pratensis a short blunt one. While the smooth-stalked meadow grass is found chiefly in dry pastures, the rough-stalked principally occurs in moist meadows, or on the edge of wet ditches. It loves moisture and a sheltered situation; hence, though there are few grasses more productive, or better adapted for hay or pasturage, it is a tender grass, and liable to be injured by severe cold or excessive drought.

Crested Dog's-tail Grass (cynosurus cristatus).

98.

a Crested Dog's-tail Grass. *b* Meadow fescue Grass.

This grass grows naturally in dry situations, and will not thrive in meadows that are very wet. It flowers about the middle of June. It produces but little foliage, and its stems are dry and wiry. It is found abundantly in sheep pasture grass, and those animals are said to relish it; but other cattle are not fond of it; and on the whole, it is not a grass to be recommended for culture.

Meadow fescue Grass (festuca pratensis). This in appearance and qualities nearly resembles the *ray grass*, and indeed is reckoned by some to have several superior qualifications. It is larger and more productive in leaves; it is strictly perennial; is very hardy, and will thrive not only in very wet, but also in dry ground. It produces numerous seeds, which are easily collected, and which readily germinate when sown. It is late of flowering, however, as it does not put forth its panicle till the middle of June. It differs from the *tall fescue grass* in being of a much smoother and more succulent quality.

Ray or *Rye Grass, darnel (lolium perenne).* This grass, originally brought from Norfolk, has now obtained a universal celebrity as one of the best of the cultivated grasses. It is peculiarly adapted both for hay and pasture, especially in wet or uncertain climates. It flowers in June; and if cut in this month it again flowers the same sea-

99.

Ray or Rye Grass.

son, though not with the same vigour. In the dry soils of Scotland this grass affords the sweetest of our early pastures, especially in fields in which it has been recently sown; and if eaten down close and even, it rises again repeatedly, to be again consumed in the same season. If it is permitted, however, to rise into flower stalks, and especially if these are permitted to stand till they whiten, it is in that state disliked, as most of the other grasses in a similar state are, by every grazing animal. In this country, sheep, horses, and cattle, relish it much before the stalks have seeded. For post and work horses it makes the best and most substantial hay, and is particularly adapted for intermixture with clover crops. There are three species of this plant: *lolium perenne*, perennial rye grass or red darnel; *lolium tremulentum*, annual rye grass or bearded darnel; *lolium arvense*, annual white or beardless darnel. The perennial rye grass is characterised by being less tall in the stalk than the others; but the roots are larger and send up more stalks, the spike has no awn, there are fewer flowers, and those are more tapering and pointed at the extremities. It also flowers earlier than the annual plant. The white beardless darnel resembles the *lolium tremulentum*, only it has no awns, is of less dimensions, and feels smooth along the stalk and spine; but from these characters it may possibly be mistaken for the perennial plant. The reddish colour of perennial rye grass, ample stalks, and large roots, are the readiest marks to the farmer's eye. The distinctive marks in the floral organs between the *l. perenne* and *l. tremulentum* are, that the spicules in the first are longer than the calyx, and the flowers beardless; whereas, in the second, the spicules are only of equal length with the calyx, and the flowers have short beards. The seed of the perennial is characterised by a reddish colour; if fresh, a sweet smell, a small size of body, not swelling much in the middle, but of considerable weight, and no appearance of awn or beard. The annual species is much less suited to the general purposes of the agriculturist, although it is said by some to yield the heaviest crop of hay.

Water Meadow Grass (poa aquatica). This grass grows naturally in standing waters, or land that is periodically overflown. Accordingly, in flat countries, which do not admit of being sufficiently drained, it is almost the only grass for hay and pasturage.

Dwarf Meadow Grass (poa annua). A grass common to every quarter of the globe where cold does not prevent it, perpetually flowering and seeding, and that most rapidly; growing in almost any soil and situation; varying in size, but never acquiring any great height; its foliage tender and grateful to cattle; but liable to be killed by winter's frost and summer's drought; hence frequent in the edges of paths, where its seeds being scattered, quickly vegetate, and where it is not overpowered by more luxuriant herbage.

Creeping bent Grass, or *fiorin Grass (agrostis stolonifera).* This grass is characterized by long strings, with lively green sprouts issuing from them at right angles, at a few inches distant from each other. The strings vary in length, from one to ten feet, in summer always green. Sometimes part of these have a dull blood-red shade, whence probably the grass got the name of red robin. Most of the strings whiten in winter, when not covered up by their own mat, or by water, when they preserve their green colour, the whiteness being confined to the envelope. Fiorin has scarcely any root, the slightest catch of the earth being sufficient for its existence and nourishment. It is indifferent to the extremes of wet or drought, though most luxuriant with an ample allowance of moisture; neither is it influenced by high or low ground, or extremes of heat or cold. There is no soil so dry or poor, or no situation so excluded from sun and air, but where it will find a lodgment, and grow and flourish. This grass is never propagated by seeds, which are small and slow of growth. It is planted by laying down the strings. These strings, laid on a bare surface, any time from the 10th September to 1st April, and lightly sprinkled with earth or compost, so as nearly to cover them, will soon vegetate, and in a short time clothe the surface with a uniform verdure. It is reputed to produce from five to ten tons of good hay per acre.

The natural families *Cyperaceæ* and *Junci*, contain plants nearly allied to the grasses; such are the reeds and rushes, a few of which we shall enumerate.

The *Papyrus (cyperus papyrus)*, is an aquatic plant, with large tortuous roots, a triangular stem, from fifteen to twenty feet in height, gradually tapering to the top, surmounted by a tuft of fine fibrous filaments, which subdivide into still smaller, on which are the small seedy flowerets. This plant is celebrated as that which yielded the paper of the ancients, which was made from the inner bark of the stem. This

100.

Papyrus.

liber or bark is composed of thin laminæ or plates, and these unrolled and placed together formed a sheet. The plates obtained near the centre were the best, and each cut diminished in value in proportion as it was distant from that part of the stem. When carefully peeled from the plant, and dressed at the sides, that these might join evenly, these plates were laid close together on a hard flat table, and then other pieces similarly cut were laid across them at right angles. They thus formed a sheet of many pieces, and to promote their adhesion, the whole was moistened with the water of the Nile, and, while wet, pressure was applied. The glutinous matter inherent in the bark promoted adhesion. They were afterwards dried in the sun. Bruce the traveller, who frequently made the paper in the manner thus described, ascertained that the saccharine juice contained in the plant, and dissolved and diffused in the water, causes the immediate adhesion of the parts. In some cases where the plants themselves did not contain sufficient juice, or when the water did not dissolve the juice properly, the strips of bark were joined together with paste, made of fine flour, mixed with hot water and a little vinegar. After being dried and again pressed, the paper was smoothed and flattened by beating it with a wooden mallet.

A recent traveller thus describes the papyrus as he found it growing near Syracuse in Sicily, the only locality in Europe where this beautiful plant is found indigenous. "The river Anapus, after flowing through an alluvial plain, which requires draining very much, being in many parts swampy, and emitting the most unhealthy miasmata, falls into the sea at the west side of the magnificent harbour of Syracuse. We ascended the river for some distance in a flat-bottomed boat. Near its mouth the water was pretty deep, but muddy; and a little farther on we found it contaminated and obstructed by heaps of hemp, which were steeping there. The current was scarcely perceptible; but our progress was impeded by aquatic plants and strong high rushes, which in many places so covered the river from side to side, that we could scarcely see the water. At the distance of about an Italian mile from the mouth of the river, we first came in sight of the object of our search, the graceful papyrus plant, which we saw growing in little clusters, and shooting above groups of water-lilies on either side of the river. A quarter of a mile higher up we turned to the westward, and quitting the main stream, entered the Cyanean branch, which here forms its junction. This branch was still more covered with reeds and aquatic plants than any part of that we had come through; but unlike the Anapus, its water, when visible, was as clear as a mountain stream in Scotland. In proportion as we proceeded up this branch, which is very winding and deep, we saw the papyrus in thick groups; and as we laboured to force our way through the rich vegetable obstruction, which became stronger and stronger, the beautiful feathery tuft of the plant bending with its slim elastic stem, frequently flapped in our faces. At a short distance from the fountain head, the serpentine stream was so completely choked up with a vegetation of surprising tenacity, that having no man to tow us along from the banks, and, indeed, no assistance but such as a little boy from Syracuse could render us, we were well nigh giving up our farther progress, for the present, in despair. Persevering, however, by cutting, and tearing, and forcing our little punt through or over this matting of plants and flowers, we at last shot into the clear basin of the Cyanean fountain, well bathed with perspiration and its own waters. This famous fountain, which, coming by the famous course of the stream that flows from it, may be somewhat more than half a mile from the Anapus, is a circular pool, of from sixty to seventy feet in diameter. Its waters, though the bottom of the basin seems formed of black mud, are remarkably pure, and so transparent that you can see the fish which swarm there, and any other object far beneath the surface, as clearly as though you looked through the medium of a transparent atmosphere. According to our measurement, the fountain was then thirty-two feet deep;—it was fringed all round with the graceful *cyperus papyrus*. Nothing remained of the ancient temple of Cyane except some blocks of marble, that had fallen or been thrown into the fountain; even the name of Cyane was no longer known there, the Syracusans calling the fountain and the stream La Pisma. Few spots could be more solitary, and still the limpid water flowed without a ripple, nor were any sounds heard except the occasional twitter of a sort of

reed sparrow, and now and then the rustling of the high papyrus, and other aquatic plants, as they were shaken by a breath of summer air, or agitated by the fish gliding among their roots. The papyri fringing the pool seemed literally to float upon its tranquil waters, their principal root, which is large and bulbous, running horizontally at the surface of the stream, and long slender filaments depending perpendicularly from it, like so many little cables to keep it at anchor. The shaft or stem proceeding from this root was frequently ten feet high, without measuring the flowing tuft in which it terminated. From some of them which we cut down and carried away with us, we easily made a sort of paper, though I cannot say much of the quality we produced, being hurried and without proper implements. We were obliged to fasten the strips together, to form one sheet, with gum, which may have arisen from the Syracusan papyrus being deficient in the glutinous quality of those of the Nile, or, which is at least as probable, from our not dissolving it properly, or not giving the strata sufficient pressure. Some manufactured papyri we saw in the house of a gentleman of Syracuse were certainly infinitely superior to our own, though even those would have been a poor substitute for our English writing paper of the very worst quality. They were specimens of the result obtained by an antiquary called L. Cavalier Landolina, who, a good many years before, had endeavoured to revive the ancient manufacture, confidently anticipating that it would supplant paper, not only in Sicily, but in all Europe. It may, however, be doubted, whether paper produced from this substance, even when the ancient art was in its perfection, and the best papyri of the Nile employed, ever equalled the paper we now produce from linen rags in any one quality save in durability."

The ancient Egyptians made their sheets of prodigious length, though narrow. One of those purchased by the Earl of Belmore, and unrolled by his lordship, was fourteen feet long by one foot broad. Belzoni had a papyrus twenty-three feet long by one and a half broad. The quantity of the papyrus used by the Egyptians in their funeral operations alone must have been very great. Those papyri now found in the ancient tombs, and about the mummy caves in Egypt, are yet in a wonderful state of preservation. The rolls are always compressed. Sometimes their exterior is ornamented with gilding, in which case they are looked upon as of superior value. They are generally thrust into the breast, or between the knees of the mummy, and occasionally they are inclosed in small wooden boxes, or purses. In the museum of Naples there are not less than 1700 to 1800 MSS. papyri, which have been dug from the ruins of Herculaneum, and yet only a very small portion of this ancient city has yet been dug out of the mass of lava by which it was overwhelmed.

Several of the Junci are used for making matting and baskets. The bullrush of this country, and the *juncus acutus*, or sharp rush, are thus employed. In Holland, the sharp rush is planted with great care on their sea embankments, to prevent by its roots the action of the tides from washing away the earth. These roots are numerous, and strike very deep into the ground, and mat themselves near the surface in such a manner, as to hold the earth closely together, and whenever they are presumed to be destroyed, much assiduity is employed in replacing them. When these rushes have attained their full height, which is in summer, they are cut down, tied into bundles, dried, and conveyed to the town, where they are wrought into baskets and other useful articles.

On the banks of the Maese in England this rush attains the height of three or four feet; but in general does not grow so luxuriantly in this country. As a substitute for it, the great cat's tail, *typha latifolia*, which grows abundantly in all our swamps, and on the borders of our lakes, has been used with success. The stem of this plant is six feet long, its leaves about an inch in breadth, and convex on one side. It is terminated by a long cylindrical head, where the flowers and seeds are formed, of a dark brown colour, and five to six inches in length. The young and succulent stems of this rush, which grows in vast quantities in the swamps of Russia, are used by the Cossacks and Russian boors as an article of food, and, though mawkish and insipid, are by them esteemed a luxury.

Two of our common junci, the *conglomeratus* and *effusus*, when the outer skin is peeled off, are used for wicks in making what are called rush-lights. We learn from Pliny, that the Romans applied the pith of various kinds of rushes for similar purposes, and that they entered into the composition of the torches and candles used at their funeral ceremonies.

In Japan, rush making is a trade extensively followed. All the floors of their houses are covered with mats, which are of great beauty and variety, and many of their household utensils are fashioned out of the same materials. So late as the days of Queen Elizabeth, our halls and public places were strewed with loose rushes, so that we then had not attained the ingenuity or refinement of those eastern nations. The Japanese employ chiefly the *juncus conglomeratus* and *effusus*, hard and soft rush. Their mats are formed of the soft rush, plaited very closely, and the interstices afterwards filled up with rice straw. These mats, which are at once the carpets and the only beds used by the Japanese, are soft, elastic, and often three or four inches thick. Some law appears to regulate the size of these

mats, for, according to Thunberg, they are precisely of the same dimensions throughout all parts of the kingdom, with the exception of those in the imperial palace of Jeddo. The common dimensions were two yards long and one broad, with a narrow blue or black border. They make a lighter sort of matting of the same materials, which is used as window blinds, and to protect the transparent paper which forms a substitute for glass. Of some harder species of rush they even make shoes for their horses, which come up to the pastern joint, and cover the hoof. Rushes and mats are extensively used in many eastern countries. The sugar sent home from the Mauritius is contained in bags made of matting, which are thick, strong, and very durable.

CHAP. XXVII.

THE SUGAR CANE, BAMBOO, &c.

Of the same natural family as the cerealia, and possessing qualities little less valuable than the various kinds of grains constituting that family, is the sugar cane. Sugar, as we have already stated, is a substance found in the juices of a great many vegetables, and in its chemical composition is very nearly the same as the farina of corn. It is a grateful and nutritious substance, and from having once been esteemed as a luxury, is now almost from its universal use, looked upon as a necessary of civilized life.

The Sugar Cane (*saccharum officinarum*), belongs to the class *triandria* and order *digynia*

101.

The Sugar Cane.

of Linnæus. Its root is perennial, fibrous, and the stem simple, knotted, or undivided, jointed, and smooth. It is two inches in diameter, and from eight to eighteen and twenty feet in length; the number of joints varies from thirty to eighty. The leaves are long, amplexial, and pointed. The flowers are small, and produced in the form of a terminal loose panicle. Calyx, a glume of two valves, which are oblong or lance-shaped, pointed, erect, concave, and equal; the base being surrounded by long woolly hairs. The corolla is composed of two valves shorter than those of the calyx, and of a fine delicate texture. The germ is oblong, and supports two feathered styles terminated by a plumous stigma; the seed is oblong, and is invested by the corolla.

There are now several varieties cultivated in the American colonies, which were introduced there about the end of the last century from the islands of Bourbon, Java, and Otaheite. These are so far superior to the old plant, that they have almost superseded its culture. The new varieties are larger in diameter, the joints are farther separated from each other, and the plants arrive several months sooner at maturity than the old canes. Thus the old Brazilian cane takes from twelve to twenty months to arrive at maturity, while the new varieties are ready in about ten months.

The nature of the soil and mode of culture have a considerable effect on the size of the plants. In a favourable soil, and in new and moist lands, it reaches to the height of twenty feet, while in dry and light soils it does not exceed six or ten feet. It is always propagated from cuttings, for although many attempts have been made to raise plants from seed, these have always proved unproductive. Bruce affirms that he has seen it raised from seed in Nubia, and there must certainly be some country where the seeds prove productive, else nature would not have been so lavish in bestowing them on this as well as every other plant. Neither the Greeks or Romans were acquainted with the sugar cane, or at least cultivated the plant as an article of luxury. It is supposed that Theophrastis alludes to it when he mentions, that besides being procured from bees, honey, or sweet juice, is also the product of canes. The sugar cane, however, seems to have been early cultivated in China and India, and from the latter region it is probable it was introduced into Europe. Before the discovery of the West Indies by the Spaniards in 1492, or of the East Indies by the Portuguese in 1497, sugar was manufactured from the sugar cane in considerable abundance in the islands of Sicily, Crete, Rhodes, and Cyprus. The plant is supposed to have been brought to these islands originally by the Saracens, and from thence transported into some parts of Italy; and to Spain from Africa by the Moors. In Spain the sugar cane was first planted in Valencia, and afterwards in Granada and Murcia. In these southern districts of the kingdom, sugar was at one time produced in

great quantity. Mr J. Willoughby, an English traveller in Spain in 1664, says, "I went to Olives in Valencia, where, as well as at Gandia, are engines for sugar works; the best are at Olives. By the way we saw the sugar canes growing at several places. They are planted in low wet grounds, well manured and dressed, divided into beds or hillocks and furrows. They cut the canes close to the roots in November and December, and cutting off the slender tops, which afford no good juice, keep them under ground till March, and then prick them into these hillocks or beds. Out of every *talea* or cut shoot four, five, or six canes, which will be ripe next December. The knots or joints of the cane at the bottom are very close together, scarce an inch asunder; but upwards the distance is more, as the cane grows more slender. Within is a white pulp or pith, full of sap, sweet as honey. They sell them at Gandia to eat, and cutting them in pieces just in the middle between two knots, suck the pieces at both ends. To make sugar, after the canes are cleansed from the tops and leaves, and cut to pieces, they are first bruised either with a perpendicular stone running round, as apples to make cyder, or olives to make oil, or between two axles strongly capped with iron, horizontally placed, and turned contrary ways, and then pressed as grapes or olives are. The juice thus pressed out is boiled in three several cauldrons, one after another. In the third cauldron it becomes thick and black, and is then put into conical pots, which at the bottom have a little hole stopped only with coarse and foul sugar. These pots are covered when full with a cake of paste made of a kind of earth called the Spanish *gritty*, and found near Olives, which is good to take spots out of clothes, and which cap or cover sinks as the sugar sinks. These conical pots are put into others of another shape by the hole at the vertex, and the juice drains down through the coarse sugar at the bottom. It drains for five or six months, in which time the sugar in the conical pots grows hard, and while all the juices being drank up by the late, or run out by the hole in the vertex, the juice is boiled again so long as it is good for any thing, but at last it makes only a foul red sugar that will never be better. The conical loaves of sugar, after they are taken out, are set to drain over the same pots for fourteen or fifteen days. To make the sugar more white they must boil it again, but about one-sixth is lost every time. A pound of sugar of twelve ounces is sold at Olives for three sous and a half, refined for five or six sous, (equal to 3d. of English money.) The sugar juice is strained through linen strainers, and is put out of one cauldron into another. They take it out of the first and second cauldrons so soon as it begins to boil; but in the third cauldron they let it boil till the scum rises, and then take off only the scum with the scummer, and put it into a long trough to cool; and when it is cool, put it into the conical pots. One scum rises after another in the third cauldron. The scum when it is taken off is white, but turns to a black liquor in the trough. They never refine the sugar more than three or four times. They use for the refining of it whites of eggs, putting in two or three dozen into a cauldron, and they use but one cauldron for refining. When the process is finished it grows hard, and white in nine or ten days."

From Valencia, the cultivation of the sugar cane, and the manufacture of sugar, were carried in the beginning of the fifteenth century by the Spaniards to the Canary islands, and the commerce arising from the sugar then produced was considerable, but prior to this period the Portuguese, in 1420, carried the cane and the manufacture of sugar from the island of Sicily to Madeira. From these origins the cultivation of the sugar cane, and the art of making sugar, were extended by different nations of Europeans to the West Indian islands and the Brazils.

This progress of the cultivation of the sugar cane has, however, given rise to the supposition that the Europeans propagated this plant from Sicily and Spain to Madeira and the Canary islands, and from thence to the West Indian islands and the continent of South America, and that it was not an original and indigenous plant in those localities. There are good grounds for supposing, however, that this opinion is incorrect; and although there are no very authentic accounts regarding the first settlements, or indigenous products of those islands, yet there is every reason to believe that the sugar cane was found growing in some of them, as it has undoubtedly been discovered by navigators as indigenous to all the islands of the South seas. Thus it was found flourishing in the Society islands, Easter island, and the Sandwich isles, where the natives were perfectly acquainted with the use of its expressed juice, though they had not the knowledge of making sugar. Some plants of those canes were introduced into the West Indies, and the astonishing increase of sugar, which those brought from Otaheite and planted in Jamaica yielded over those of the island, showed if they were not distinct species, that the plant, like many others, improved greatly by a change of soil and climate. Sir John Laforey, who introduced some of the Otaheitian as well as Indian canes into the island of Antigua, thus gives an account of them. "There was one sort brought from the island of Bourbon, reported by the French to be the growth of the coast of Malabar. Another sort from the island of Otaheite; a third from Batavia. The two former are much alike both in their appearance and growth, but that of Otaheite is said to

make the finest sugar. They are much larger than those of our islands, the joints of some measuring eight or nine inches long, and six in circumference. Their colour and that of their leaves also differs from ours. They are ripe enough to grind at the age of ten months. They appear to stand the dry weather better than ours, and are not liable to be attacked by that destructive insect called the *borer*. The Batavian canes are a deep purple on the outside; they grow short-jointed, and small in circumference, but branch exceedingly, and vegetate so quick, that they spring up from the plant in one-third of the time which those of our island do."

When Europeans first visited America, the sugar cane was found growing in the low lands near the mouth of the Mississippi. Father Hennepin says, "From thirty leagues below Maroa down to the sea, the banks of the Mississippi are full of canes;" and Francis Ximenes mentions the sugar cane as growing spontaneously near the Rio de la Plata. John de Laet also mentions it as indigenous in the island of St Vincent.

Jamaica was discovered by Columbus in his second voyage in 1494, and a settlement was made there by the Spaniards in 1509. In 1656 it was taken possession of by the English, and the sugar cane first planted there for the purpose of sugar making in 1660. Sir Thomas Modiford, who afterwards became governor of the island, introduced the art of sugar cultivation, and the necessary canes from the island of Barbadoes. In this latter place the production of sugar had been sedulously carried on chiefly under his auspices for many years previous. Ligon, in his history of Barbadoes, thus writes on the subject: "At the time we landed on this island, which was in the beginning of September 1647, we were informed partly by those planters we found there, and partly by our own observations, that the great work of sugar making was but newly practised by the inhabitants there. Some of the most industrious men having gotten plants from Fernambrock, a place in Brazil, and made trial of them at the Barbadoes; and finding them to grow, they planted more and more as they grew and multiplied on the place, till they had such a considerable number as they were worth the while to set up a very small ingenio, and so make trial what sugar could be made on that soil. But the secrets of the work being not well understood, the sugars they made were very inconsiderable and little worth for two or three years. But they finding their errors by their daily practice, began a little to mend, and by new directions from Brazil, sometimes by strangers, and now and then by their own people, who were content sometimes to make a voyage thither to improve their knowledge in a thing they so much desired. Being now much better able to make their queries of the secrets of that mystery, by how much their often failings had put them often to stops and non-plusses in the work; and so returning with more plants and better knowledge, they went in upon fresh hopes, but still short of what they should be more skilful in; for at our first arrival we found them ignorant in those main points that much conduced to the work, viz., the manner of planting, the time of gathering, and the right placing their coppers in their furnaces, as also the true way of covering their rollers with plates or bars of iron. At the time of our arrival there, we found many sugar works set up and at work, but yet the sugars they made were but bare Muscovadoes, and few of them merchantable commodities, so moist and full of molasses, and so ill cured or dry, they were hardly worth bringing home to England. But about the time I left the island, which was in 1650, they were much bettered, for then they had skill to know when the canes were ripe, which was not till they were fifteen months old, while before they gathered them at twelve, which was a main disadvantage to the making good sugar, for the liquor wanting of the sweetness it ought to have, caused the sugars to be lean and unfit to keep. Besides they had grown greater proficients both in boiling and curing them, and had learnt the knowledge of making the white, such as you call lump sugar here in England, but not so excellent as those they make in Brazil; nor is there any likelihood they can ever make such, the land there being better, and lying in a continent, must needs have constanter and steadier weather, and the air much drier and purer, than it can be in so small an island as that of Barbadoes.

The rearing of canes and the manufacture of sugar has now become the chief employments in the West India islands, and immense quantities of this article are annually exported from them. The culture of the cane, therefore, has now become an object of anxious solicitude. We have already said that the cane is propagated by cuttings alone. The top joints are always selected for this purpose, because they are less rich in saccharine matter than the lower parts of the cane, while the vegetating powers are equally strong. The cane-plant is possessed of the power of tillering, in a manner similar to that shown by wheat, although not to an equal extent.

In preparing a field for planting with the cuttings of cane, the ground is marked out in rows three or four feet apart, and in these lines holes are dug from eight to twelve inches deep, and with an interval of two feet between the holes. Where the ground is level, larger spaces are left at certain intervals for the facility of carting; but there are many situations at the sides of steep hills where no cart can be taken, and in such cases these spaces are not required. The

ripe canes are then conveyed to the mill in bundles on the backs of mules, or are passed down to the bottom of the hill through wooden spouts.

The hoeing of a cane-field is a most laborious operation when performed, as it must be, under the rays of a tropical sun. Formerly this task was always effected by hand labour; but of late years, where the nature of the ground will admit of the employment of a plough, that instrument has been substituted, to the mutual advantage of the planter and his labourers. The planting of canes does not require to be renewed annually; in such a case the utmost number of labourers now employed on a sugar plantation would be wholly inadequate to its performance. The most general plan is for a certain portion of the land in cultivation to be planted annually and in succession, the roots and stoles of the canes of the former year being left through the remaining parts of the plantation. From these, fresh canes, which are called rattoons, spring up, and are nearly as large the first year as plant canes. Rattoon canes have a tendency to deteriorate, at least in size, every year they are continued, for which reason the progressive renewal of the plants is adopted. This plan may, however, be continued with very good effect for several years, provided the roots are furnished every year with a liberal supply of manure, that the ground about them is well loosened, and that all weeds are carefully removed. In this way it is said the same roots have been made to send up canes during twenty years. In some few cases the planters adopt a different course, and never wholly renew any individual field of canes, but content themselves with supplying new cuttings in such particular spots as from time to time appear to be thin.

The mode of cultivation varies in some particulars in different countries. In India, where the price paid for daily labour is exceedingly small, great pains are taken in preparing the ground for the reception of the plants, which are carefully weeded and watered, and freed from insects, at all periods of their growth, when such operations are called for. Unfortunately for the Indian sugar-cultivator, something more than mere labour is required for the proper manufacture of his produce—an acquaintance with chemical science, and the possession of adequate apparatus—in both which particulars he is lamentably deficient. The Indian agriculturist would suffer martyrdom rather than be guilty of the crime of innovation. The discoveries of scientific men are to him as though they never had been made; and in conducting processes he is contented with apparatus, the total cost of which does not exceed many shillings, where manufacturers of other countries think it necessary to expend many hundred pounds. If their inveterate prejudices could be overcome, and the Indian sugar-planters were furnished with adequate utensils, there is every reason to believe that the markets of Europe could be supplied thence with sugar of a quality quite equal to that of West-India manufacture, and at a considerably lower cost.

The manufacture of sugar is a somewhat complicated process, requiring for its successful performance not only some degree of chemical knowledge, but likewise a considerable amount of practical experience. We have already quoted Willoughby's description of sugar-making in Spain before its introduction into the West Indies, and the following is a summary of the modern practice in the colonies.

When the canes are fully ripe they are cut close to the stole, and being then divided into convenient lengths, are tied up in bundles, and conveyed to the mill. This always consists of three iron cylinders, sometimes standing perpendicularly in a line with each other, and at other times placed horizontally, and disposed in the form of a triangle, and so adjusted that the canes, on being passed twice between the cylinders of either kind of mill, shall have all their juice expressed. This is collected in a cistern, and must be immediately placed under process by heat to prevent its becoming acid, an effect which has sometimes commenced as early as twenty minutes from the time of its being expressed. A certain quantity of lime in powder, or of lime-water, is added at this time to promote the separation of the feculent matters contained in the juice; and these being as far as possible removed at a heat just sufficient to cause the impurities to collect together on the surface, the cane-liquor is then subjected to a very rapid boiling, in order to evaporate the watery particles, and bring the syrup to such a consistency that it will granulate on cooling. The quantity of sugar obtainable from a given measure of cane-juice varies according to the season, the soil, the period of the year, and the quality of the canes; but it may be calculated, that, taking one state of circumstances with another in these respects, every five gallons, imperial measure, of cane-juice, will yield six pounds of crystallized sugar, and will be obtained from about one hundred and ten well-grown canes.

The fuel used for thus concentrating the juice is furnished by the cane itself, which, after the expressing of that juice, is dried for the purpose by exposure to the sun.

When the sugar is sufficiently cooled in shallow trays, it is put into the hogsheads wherein it is shipped to Europe. These casks have their bottoms pierced with holes, and are placed upright over a large cistern into which the molasses —which is the portion of saccharine matter that will not crystallize—drains away, leaving the raw sugar in the state wherein we see it in our

grocers' shops: the casks are then filled up, headed down, and shipped.

With the planters in our own colonies, the process of sugar-making mostly ends with the draining away of the molasses in the manner just mentioned; but in the French, Spanish, and Portuguese settlements, it is usual to submit this raw sugar to the farther process of claying. For this purpose the sugar, as soon as it is cool, is placed in forms or moulds, similar to those used in the sugar refineries in England, but much larger; and these being placed with their small ends downwards, the top of the sugar is covered with clay moistened to the consistence of thin paste, the water contained in which gradually soaks through the sugar, and washes out a farther quantity of molasses, with which it escapes through a hole purposely made at the point of the earthen mould. It is then called clayed-sugar. The loaves, when removed from the forms, are frequently divided into three portions, which, being of different colours and qualities, arising from the greater effect of the water in cleansing the upper portion, are pulverized and packed separately for exportation.

The molasses which have drained from the sugar, together with all the scummings of the coppers, are collected, and, being first fermented, are distilled for the production of rum. The proportionate quantity of this spirit, as compared with the weight of sugar produced, varies considerably with the seasons and management. In favourable years, when the canes are fully ripened, and the quality of the sugar is good, the proportion of molasses and scummings is comparatively small, and the manufacture of rum is consequently lessened. The proportion usually made is reckoned to be from five to six gallons of proof spirit for every hundred-weight of sugar.

The Bamboo *(bambusa arundinacea)*. This gigantic member of the family of reeds and grasses has, when growing, an appearance not unlike an immense sheaf of wheat standing on end (see Plate VII., fig. 1.) Some of them are upwards of sixty feet in height, and the quantities of single canes which they yield is prodigious. The cane is porous in the centre, and partly hollow. Externally the epidermis is composed of a hard wood, into which silex enters so largely, that it will strike fire with steel in the same way as a piece of flint. This plant is indigenous to China; and although it grows spontaneously and most profusely in nearly all the immense districts included in the southern portion of that empire, yet the Chinese do not entirely rely on this profusion of nature, but cultivate the reed with much care. They have treatises entirely devoted to this matter, where all the rules of experience are propounded for its culture, showing the proper soils, the best kind of water, and the appropriate seasons for planting and transplanting this most useful production. Among this singular people, the bamboo is used for almost every article of convenience or luxury. Marco Polo says, that in his time they had canes thirty English feet in length, which they split in their whole length into very thin pieces, and then twisted them together into strong ropes three hundred passi (six hundred English feet) long, that were used to track their vessels on their numerous rivers and canals. M. De Gurgenes says, that in the course of his journey through part of the celestial empire, he often saw the Chinese making this kind of rope. The artizans were mounted on scaffolds twelve or fifteen feet high, and let the cord fall to the ground as it was plaited. Van Braam, another modern traveller, speaks of this bamboo cordage as being admirably light and strong. The sails of the Chinese junks, as well as their cables and rigging, are made of bamboo. The old Venetian also describes a pavilion of the grand Khan, the roof of which was made of bamboo cane, richly gilt and varnished. These bamboos, he says, were each three palms in circumference, and ten fathoms long, and being cut at the joints, were split into two equal parts, and laid concave and convex to form gutters. The missionaries inform us, that not merely the roofs, but entire dwellings, are constructed of bamboo; this is particularly the case in the southern province of Se-chuen, where nearly every house is built solely of this strong cane. Moreover, almost every article of furniture, mats, screens, chairs, tables, bedsteads, bedding, are all made of the same material. This curious people also convert the fibres of this plant into paper. In short, as Van Braam remarks, scarcely any thing is to be found in China, either upon land or water, into the composition of which bamboo does not enter or to the utility of which it does not conduce. The same extensive use of the hollow reed is made in Japan; nor is it much less employed in Java, Sumatra, Siam, Pegu, the Ladrone islands, and other eastern countries. Even the young shoots of the bamboo afford the Chinese an article of food, and its fibres serve them for candle wicks.

The Indian Cane (calamus verus), plate VII. fig. 2, grows straight and tall, without branches, and is surmounted by a tuft or crown. Its bark is thickly covered with straight spines; but this being removed, the straight smooth cane is displayed. Sumatra produces this plant in great abundance. Formerly the Dutch monopolized the sale of canes from that quarter, and we were accustomed to purchase them from this people, who studiously withheld all information concerning the plant from which they were obtained, fearing lest travellers should discover how easily and plentifully they were procured. The secret, however, could not long be thus kept. As our

navigators found their way to the eastern islands and different parts of the Indian ocean, they became well acquainted with the cane-plant, and the great variety of uses to which it might be applied. At Java, as well as at Sumatra, at Japan, Malacca, Siam, Pegu, and many other places, the rattan was found in great abundance. The natives of Java cut the cane into fine slips, which they plait into beautiful mats to sit upon, manufacture into strong and neat baskets, or twist into cordage. With them it supplies the place of our string or twine, for all their parcels are neatly tied up with the fibres of cane. The fruit it bears, which, when ripe, is of a round form, about the size of a hazle nut, and lies in clusters, they sell in the markets as an article of food. They sometimes suck the pulp to quench thirst, and at other times pickle the fruit. Twisted cane forms the cables of their ships. At Malwia was a manufactory of this sort of cable. "Here," says Dampier, "we made two new cables of rattans, each of them four inches about; they were strong and serviceable, and had the property of buoyancy in the water, not sinking like our hemp cables." In Japan the natives make all sorts of upholstery work from the split pieces of the cane.

CHAP. XXVIII.

THE FAMILY OF PALMS, THE COCOA NUT, DATE, DANNANA, WAX-PALM, &c.

The family of palms form one of the most magnificent in the vegetable kingdom. Intermediate in their structure, between herbaceous plants and trees, they possess the towering height and the umbrageous shade of these latter glories of the vegetable tribes, with an elegance of form and beauty of proportion not inferior to any of the denizens of the woods or forests. They are all natives of tropical regions, and bring to us associations of bright and sunny skies, and a temperature in which their leafy shade and the cooling products which they yield must be peculiarly grateful and appropriate.

The palms are generally large trees, with a simple, cylindrical, leafless stem, designated by the name of Stipe. At its summit, the palm is crowned by a bundle of very large, petiolate, persistent leaves, which are pinnate or decompound, with a greater or less number of leaflets of diversified form. The flowers are hermaphrodite, or more commonly unisexual, diœcious or polygamous, forming catkins, or a large cluster named regime, and enveloped previous to its expansion in a coriaceous, sometimes ligneous spatha. The perianth has six divisions, of which three are inner and three outer, so as to resemble a calyx and a corolla. The stamina are six, rarely three. The pistil is simple, or formed by the aggregation of three distinct or united pistils. It presents one or three cells, each containing a single seed. Each pistil is terminated by a style, surmounted by a more or less elongated stigma. The fruit is a fleshy or fibrous drupe, containing a very hard bony nucleus, with one or three monospermous cells. The seed, besides its proper integument, consists of a fleshy or cartilaginous endosperm, sometimes presenting a central or lateral cavity. The embryo is very small and cylindrical, and is placed horizontally in a small lateral depression of the endosperm.

With the exception of the fan-palm (*Chamœrops humilis*), all the plants of this family are extra-European, inhabiting especially the intertropical regions of the old and new continents. These trees are not only remarkable for the elegance of their form and the prodigious height which several of them attain, but are also of the greatest importance on account of the numerous services which they render to the inhabitants of the countries in which they naturally grow. The fruits of many species, as the cocoa, the date, and the terminal bud of the cabbage-palm are eaten by the inhabitants of Northern Africa and India. Several species furnish an amylaceous fecula named sago; others an astringent principle, similar to dragon's-blood. Some again yield a fixed oil, as *Ælais guineensis*, from which the palm-oil is procured. The *betel-nut*, which possesses an intoxicating and narcotic power, is the product of the *areca catechu*. There are upwards of one hundred and thirty known species of palms.

One of the most interesting of the palm tribe is the cocoa nut tree, both as regards the variety and the utility of its products. The following account of this tree by Mr Marshall is so full and complete as leaves nothing farther to be desired on the subject.*

The Cocoa Nut Tree *(cocus nucifera)* belongs to the class *Monœcia*, order *Hexandria*, of the Linnean classification of plants.

Stem erect, without branches, from sixty to ninety or 110 feet in height, and from one to two feet in thickness. See Plate IV. fig. 3. It is marked with parallel rings from the cicatrices of the fallen leaves, about two of which separate annually. By these cicatrices or marks the age of a tree may be ascertained.

The stem is crowned with a bunch of about twelve or fifteen fronds (palm-leaves), each twelve or fourteen feet long, and composed of a double row of opposite sword-shaped leaflets, in length from three to four feet; upper leaves are erect, middle horizontal, lower ones rather droop-

* The Natural and Economical History of the Cocoa Nut Tree.

ing. A single leaf closely resembles an ostrich-feather magnified a great number of times beyond its natural size.

102.

Cocoa Nut and Flower.

The flower is axillary, and proceeds from a large single-leaved pointed spathe, which always opens on the under surface. The spadix is spicate; each spike has towards its base one or two female flowers, the others being male. In both male and female flowers the calyx has three divisions, and the corolla three petals. The male flowers have six stamens, and the female three stigmas. Drupe oval, three-sided, about eight or ten inches long, exterior covering smooth, interior fibrous; nut monospermous, very hard, has three unequal holes at the base closed with a black membrane; medullary part nearly half an inch thick, white, hard, commonly filled with a sweetish watery liquid. Ripe nuts are known by a succussion of the water they contain, when shaken.

A recticulated substance, resembling coarse cloth, (*Matulla*, Singhalese,) involves the base of each leaf, which falls off before the leaf has attained a state of maturity. In Bengal, this filamentous body is supposed to harbour insects, which are destructive to the tree: on that account, it is there destroyed by fire.

The roots are slender, and very flexible: they rise separately from the bottom of the trunk, some sink into the earth, while others take a horizontal direction very little under the surface. They do not penetrate an indurated soil.

The tree when young bears a near resemblance to a herbaceous plant; indeed, during the whole progress of its growth it has some analogy with vegetable productions of this kind. It has no bark; the surface appears to be formed of the cicatrices, which succeed the fall of the leaves, much hardened by the action of the air and sun. A slight wound in the central bud is fatal to the tree; but the hardened trunk is capable of bearing considerable injury with impunity.

Cocoa nut trees are often struck by lightning, which frequently kills the terminal leaf-bud, and thereby occasions the death of the tree. This tree never changes the diameter it has once acquired. Should any circumstance occur capable of retarding the growth during one or more years, such as transplantation, the effect is very evident in the stem by a permanent contraction in its diameter. Immediately above those blighted parts small roots sometimes protrude, but they seldom extend beyond a few inches. Frequently the trunk has a larger diameter at the base and top than in the middle.

The wood of the stem is composed of hard, flexible, ligneous, black fibres, united by a soft brownish cellular substance, capable of being reduced to powder. The palms have in the interior structure of their trunks no analogy with other trees. Their manner of growth may be compared to that of the white lily, whose stems, "though of annual duration, are formed nearly on the same principle as that of a palm, and are really a congeries of leaves rising one above another, and united by their bases into an apparent stem." In habit and in structure they resemble the ferns, in their blossom the grasses, and the asparagi in their mode of fructification. All the palms have in a greater or less degree a spongy structure. The cellular substance of the *Cycas circinalis* (sago-palm) is, in some of the islands of the eastern Archipelago, manufactured into the nutritive substance called sago, or sagu,—a word which is said to mean *meal* in the dialect of Amboyna. The *Caryota urens* (nepery tree) yields a considerable quantity of fecula, or sago; but in Ceylon this substance is not extracted, except during a period when rice is scarce. Sago is easily obtained from the interior part of the trunk of these trees. The process consists in pounding the spongy or cellular texture of the stem,—sometimes erroneously called the pith,—and washing it with water, which is strained, to separate the ligneous fibres from the fecula. Sago is grained by moistening the flour, and pressing it through a sieve, into a shallow iron pot, that is suspended over a fire, by which means it assumes a globular form. In consequence of being half-baked during the process of granulation, it may be kept a long time without undergoing a chemical change. Sago is not manufactured in Ceylon, although the tree grows there in abundance. The exterior lamina of the stem of a cocoa nut tree is always much harder than the interior.

There is a variety of this palm called the King's cocoa nut, the fruit of which has a bright yellow colour. Nuts of this kind contain a great proportion of fluid, which, on account of its supposed cooling quality, is given to invalids, in preference to that of the common nuts; but they are not esteemed so good as common nuts for culinary purposes.

The nut known by the name of the Maldive cocoa nut, *Gundira* (Singhalese,) Sea cocoa nut, Double cocoa nut, Nux medica (*Borassus Sechellensis*), is the produce of a palm-tree, which Rochon tells us abounds in the isle of Palms, one of the Seychelle islands, but nowhere else. The fruit presents an appearance of two thighs;

in other respects it is not materially different from the common cocoa nut. The nuts which are occasionally found at the Maldive islands have been carried there by currents from the place of growth.

Great medicinal virtues are ascribed to this nut by the indigenous inhabitants of India, both in the prevention and cure of diseases. The venereal disease is supposed to be radically cured by it. Thunberg says, it is deemed a sovereign remedy against the flux, epilepsy, and apoplexy. Rochon tells us that it was not uncommon at one time to see them sold for upwards of £400 Sterling each. The Emperor Rodolph the Second could not procure one at the price of 4000 florins. Some of the wealthy Indians had cups made of them, which they ornamented with gold and precious stones. They are now more generally diffused than formerly, and consequently much less valuable. Malte Brun informs us, that it has been found profitable to cultivate them in the isle of France. Many of the mendicants in Ceylon have nuts of this kind, in which they put the provisions they receive in alms.

The tree sometimes bears fruit in five or six years from the time it is transplanted from the seed-bed, but the produce is rarely abundant before the eighth or ninth year. It continues to yield fruit for sixty or seventy years. In good soils, and particularly during wet seasons, the tree blossoms every four or five weeks; hence there are generally fresh flowers and ripe nuts on the tree at the same time. There are commonly from five to fifteen nuts in a bunch; and, in good soils, a tree may produce from eight to twelve bunches, or from eighty to 100 nuts annually.

Cocoa nut trees are sometimes much injured by several species of the Coleopterous tribe of insects. They excavate a hole of about an inch diameter in the terminal leaf-bud, and, when the leaves expand, the leaflets appear full of holes, as if they had been perforated with shot of different sizes. In consequence of the injury done to the bud by these insects the trees are sometimes killed. The larva or grub of one of the species of beetles which infest cocoa nut trees is called *Tucuma* or *Grugru* in British Guiana. It is about two or three inches long, and three quarters of an inch in diameter, and the head is black. They are reckoned a great delicacy by wood-cutters and epicures of that country; and they are generally dressed by frying them in a pan. By some they are preferred in a raw state; and after seizing them by the black head, they are dipped in lime juice, and forthwith swallowed.

This species of the palm family has its habitat in intertropical Asia, Australia, America, and Africa. It is by some authors said to have in ancient times been cultivated in Arabia; but Niebuhr informs us that it is not found to the north of Mocha. Like all other equinoctial plants, the cocoa nut tree becomes less luxuriant as we approach the tropics. At the suggestion of Mr Dunlop, who lately, in so able a manner superintended the clearing of Saugur island, at the estuary of the Hooghly, that den of tigers is likely to be a continued grove of cocoa trees. Saugur lies in N. Lat. 21° 30′, which is perhaps as far from the Equinoctial line as that species of palm can be cultivated with advantage. In the neighbourhood of Lucknow, which lies in N. Lat. 26° 24′, the cocoa nut tree grows, but it does not produce fruit. As the cocoa tree seems to require for its perfection a mean temperature of not less than 72° Fahrenheit, the proper climate for it will therefore be from the equator to the 25th parallel of latitude, and in the equinoctial zone to an altitude of about 2900 feet. This general statement will no doubt admit of some qualification in regard to particular situations. There may be exposed spots within its favourite climate, where the fruit will not come to maturity, and warm valleys beyond the above limits, where the tree will grow, and perhaps produce ripe nuts. The cocoa tree occupies, therefore, a zone of 25° of latitude on both sides of the equator, which includes nearly four-fifths of Africa, one-sixth of Asia, one-third of America, and excludes Europe. It may be remarked, that trees which grow in the immediate neighbourhood of the sea are much more luxuriant and productive than those which are planted inland or upon elevated situations. The cause of this degeneration is not very evident.

The cocoa tree is much cultivated on some parts of the east coast of America; from the river St Francisco to the bar of Mamanguape, or from about 7° 30′ to 10° S. Lat., being about ninety-four leagues, the Brazilian coast is with few interruptions planted with cocoa trees. The small island of Itarmaraca, which is only three leagues in length, yields annually about 360,000 nuts. But perhaps this palm is no where so extensively cultivated as in Ceylon; and the following remarks regarding its products are intended more immediately to apply to the tree as it grows in that island. The cocoa tree is cultivated both in the interior of Ceylon and along the flat country adjoining to the sea; it thrives best, however, on the coast of the south-west aspect of the island, or from Calpenteen on the north, to Dondrahead, on the south. About the year 1813, it was estimated that 10,000,000 trees grew between these two points, and since that period the number has been annually increasing. The extent of coast between Dondrahead and Calpenteen is about 184 miles; the whole circuit of the island is 754 miles. Except cinnamon, the products of the cocoa tree form the

chief staple commodities of Ceylon. The Maldive islands produce great quantities of cocoa nuts; where they are reckoned to be the price of labour. In Congo, this palm is said to form one of the greatest blessings in nature.

It does not appear that the cocoa tree is nearly as much cultivated in the West India islands as in the east. Mr Stewart, in his account of Jamaica, says, however, that "on some estates groves of them are planted, and an oil extracted from them to light the works during crop-time. Occasionally the nuts are served out to the slaves as an article of food."

In many places along the coast of Ceylon cocoa trees thrive well upon the sandy soil near to the sea, where hardly any other plant will vegetate. These cocoa groves, through which the eye can reach for a great extent, intermixed with the huts of the natives, composed entirely of cocoa leaves, form a very picturesque object. When the trees are full grown, the bare trunks rise like columns of from sixty to 100 feet in height, while the horizontal pinnated leaves interlace, by which means a grove resembles the long aisles and Gothic arches of a cathedral: above these arches a profusion of fine leafy plumes rise from the centre of the trees, and project almost perpendicularly towards the sky, thereby adding greatly to the beauty and variety of the prospect. About thirty years since, the colonial government of Ceylon had it in contemplation to impose a tax upon cocoa trees; but, in consequence of the strongly marked aversion of the people to such a measure, the plan was abandoned. On the Malabar coast, cocoa nuts pay a land tax of half a *fanam* for every tree that is in full-bearing, old and young trees being exempted as unproductive. And, at Marzouck, in northern Africa, a tax of one dollar is levied upon every 200 trees of the date palm. Ben Ali informs us, that the king of Fezzan imposes a tax upon the same species of the palm tribe.

The cottages of the inhabitants are always surrounded by a great number of palm-trees more particularly of the cocoa nut palm; and those plants seem to thrive best which are situated near to the dwellings of the inhabitants. This circumstance has given rise to an observation of the natives, namely, that a cocoa nut tree delights in conversation. The ashes which result from the burning of wood for culinary purposes, is a more probable cause of the luxuriance of the trees close to the cottages, as the sweepings of the huts are generally deposited at the foot of a tree. The cluster of trees which surrounds a hut is called a "toddy tope" by the English. The word *tope* is probably derived from the German word *zapfen*, to draw, and hence also tap, a spout, tapsters, and tap-room. Tope has been supposed by some authors to be derived from our word *copse*. *Pol-watte* signifies a cocoa nut garden or plantation in the Singhalese language. It has been already stated that the Singhalese almost always construct their huts under the dense shadow of palm-trees of different kinds. This comfortable mode of defending habitations from the direct influence of an ardent sun, seems to have in ancient times been practised in Judea (Judges iv. 5,) and it is very generally adopted in all countries where the palm family is found to thrive.

When very young, the fruit is called *bellaca* by the inhabitants of the Malabar coast, who speak the Tamool language, and *coquinhas* by the Portuguese; Singhalese, *kooroomba*. When fully formed, but with a soft pulp, it is called *elani* by the Tamools, in Portuguese *lania*. When a little firmer, it is called *tenga* in the Tamool language, and *coquo* in the Portuguese. The mature nut is called *cotta tenga* by the Malabars, and *coquo sicco* by the Portuguese. In the Singhalese language, the nut is called *pol*. The term cocoa, by which this palm and its fruit is distinguished, is said by several authors to be of Portuguese origin. Bauhin tells us, that *cocoa*, or *coquhen*, is derived from the three holes at the end of the nut, giving it the resemblance of a Cercopithecus, a species of monkey. St Pierre, in his Harmonies of Nature, says, that a cocoa nut, stripped of its pericarp, bears an exact resemblance to the head of a negro. Piso asserts, that the term cocoa has been applied to the tree, on account of the sound emitted, when air is blown into one of the holes of the nut, having a resemblance to the voice of an ape. The Portuguese name for a monkey is *macaco*, or *macoco*. There is, however, little doubt that cocoa, is derived from the Greek word κοκος, *a seed*, or *berry*.

Uses. Cocoa nut trees are sometimes found growing on low flat coral islands, owing, probably, to the accidental circumstance of the nuts which may have dropped into the sea being thrown upon land by the waves, and hence a cocoa nut tree often becomes a useful beacon to the mariners, by pointing out the situation of rocks little above the water's edge. No plant seems to vegetate sooner on the newly formed islands of coral which are so frequent in some of the seas within the tropics, than the cocoa nut tree. By falling into rivers, the nuts are often conveyed to the ocean, and by this means they are disseminated to widely distant countries.

Roots. This part of the tree is sometimes masticated by the natives in place of the areca nut. The Brazilians make baskets of the small roots.

Wood. The hard woody shell or crust of the trunk is employed by the natives in making drums, and in the construction of their huts, &c. It is also much employed for making gutters. Towards the base of the trunk the wood is remarkably hard, and admits of a high polish. A

transverse section of this part of the tree, when well polished and varnished, has a lapideous gloss and beauty, which rival those of an agate. It is sometimes set in the lid of silver snuff-boxes, in the same manner as jewellers occasionally fix agates or cornelians; and might be found highly useful in ornamental cabinet-work.

Reticulated Cloth. In some parts of the world, it is said a kind of cradle or couch for young infants is made of the reticulated substance formed at the base of the leaf. In Ceylon it is there chiefly employed as an instrument of filtration, for straining the sweet juice which is extracted from the flowering spathe of this tree. The Reverend Mr Cordiner, in his account of Ceylon, asserts, that it "is manufactured into a durable sackcloth, called *gunny*, which is used in making bags for transporting grain," &c.; and Captain Percival says, that it is manufactured into a coarse cloth called *grinjakken (ganja sakken)* or gunny-cloth. Their statements are erroneous; gunny-cloth is chiefly made of hemp. Gunny or Goni is not improbably a corruption of ganja, the Hindostanee name of the hemp-plant, *(cannabis sativa.)* Goni cloth is also made from the *Agave Americana.* Sacks made of goni cloth are called *gunny-bags* by the English, and *ganja sakken* by the Dutch.

Buds. The unexpanded leaves or terminal leaf-bud is occasionally eaten by the Europeans as well as by natives. When boiled it is tender, and forms a good substitute for cabbage. The natives sometimes preserve it in vinegar, and eat it as a pickle. It may be observed, that the tree dies when this part is removed.

Fronds or Leaves. Many of the indigenous inhabitants, as well as natives of Europe, thatch their houses with cocoa nut leaves, by the Singhalese called *polattu*, and sometimes *cadjans.* The latter term has, we believe, a Malay origin. To prepare *cadjans*, the stipe or central ligneous portion of the leaf is divided longitudinally; the leaflets of each half are then interwoven, by which means they are adapted for a variety of uses. In this state they are employed to thatch cottages, to shelter young plants from the scorching rays of the sun, to construct fences, to form the ceiling of rooms, and to make baskets for carrying fruit, fish, &c. Sometimes baskets are made of palm leaves, so close as to serve the purpose of buckets to draw water from deep wells. In the Maldive islands, *bonneta*, a species of fish, is preserved by a process in which cocoa leaves are employed. The process consists in removing the back bone, and laying the fish in the shade, occasionally sprinkling it with sea water. After a certain period has elapsed, the fish is wrapped up in cocoa nut leaves, and buried in sand, where it becomes hard. Fish thus prepared is known in Ceylon, and perhaps over all India, by the name of *cummelmus.* The pieces of this fish brought to the market have a horny hardness. It is rasped upon rice to render it savoury. The inhabitants of several of the South sea islands manufacture a kind of mask or visor of the leaves of the cocoa nut tree, to defend their faces from the scorching rays of the sun; and this kind of armour is said to have a somewhat pleasing and graceful appearance when worn by young persons.

The unexpanded leaves are employed to show marks of respect to persons in power. When the governor or chief justice travels, lines made of the stems of creeping plants are stretched along on each side of the road, about three or four feet from the ground. Upon these lines young palm leaves are suspended. The head civil servant of a district may command the inhabitants under his immediate control to ornament the road along which he passes; but he is not warranted in claiming this mark of attention beyond his own district.

The immature leaves of the cocoa nut tree have a fine yellow colour and a beautiful texture, resembling fine leather or satin. In some parts of Ceylon, the natives evince great taste in ornamenting triumphal arches, as also ball rooms, and similar places of public resort, with the leaves of this tree, and some remarkably beautiful species of moss. As the young leaves are translucent, they serve to make lanterns, in the construction of which many of the inhabitants are very dexterous.

The practice of showing respect to individuals by means of the branches of palm trees appears to be very ancient. See Matt. xxi. 8; Mark xi. 8; John xii. 13. The foliage of the palm tribe of plants has been in many countries considered an emblem of joy and victory; and hence the word *palm* is sometimes employed as a synonym of victory and triumph. See Lev. xxiii. 40. It is remarkable that a similar mode of showing respect, by "waving palm branches," prevailed among the aborigines of America when it was discovered by Columbus. In ancient times, when pilgrims resorted to Palestine, they commonly returned bearing palm leaves; on this account they were denominated *palmers.* Captain Lyon, when describing the amusements of the natives of some parts of northern Africa, informs us, that the dancers "were directed by an old woman, with a torch in one hand, and a long palm branch in the other, and sung in chorus verses which she repeated to them." In the island of Otaheite, the female inhabitants wear bonnets constructed of the leaflets of the cocoa.

The leaflets are sometimes used to write upon, and the instrument employed to make the impression is an iron stylus, the pen of the scriptures. The stylus was used by the Romans to write on waxen tables, leather, &c. The leaves

of the palmyra *(borassus flabelliformis)*, or talipot *(corypha umbraculifera)*, are, however, much more frequently employed for this purpose. Contracts and other legal instruments are often engraven upon tablets of copper, similar in shape to a slip of the talipot leaf, which have occasionally a border of silver or gold. An allusion is made to the practice of writing upon tablets in Isa. xxx. 8, and Hab. ii. 2. Palm leaves, when they are prepared to receive the impression of the stylus, are called *ollahs*. The natives write letters to one another upon *ollahs*, which are neatly rolled up, and sometimes sealed with a little gum-lac; in this manner they pass through the post-office. During the operation of writing, the leaf is supported by the left hand, and the letters scratched upon the surface with the stylus. Instead of moving the hand with which they write towards the right, they move the leaf in a contrary direction, by means of the thumb of the left hand. To render the characters more legible, the engraved lines are frequently filled by besmearing the leaf with fresh cow dung, which is tinged black, by rubbing the lines over with cocoa nut oil, or a mixture of oil and charcoal powder. The natives can write standing as well as walking, and they rarely use tables.

Palm leaves, and perhaps the leaves of trees that do not belong to this natural class, were much used by the ancients as writing materials; hence the word *leaf* (of a book) is synonymous with that of a tree.

Baskets for catching fish, shrimps, &c., are made of the ligneous ribs of the leaflet. The same substance is employed by the natives for many of the purposes for which we use pins. A bundle of these ribs is in universal use, as a broom, to sweep the cottages; and when an European asks for a tooth-pick, his servant brings him a portion of one of these fibres. I am informed, that they have lately been recommended to be employed as a nucleus for bougies. The South sea islanders make the teeth of combs for the hair of this part of the leaf.

In a domestic state, elephants are fed chiefly upon cocoa nut leaves; and this animal evinces much sagacity in separating the elastic woody fibre from the thinner margin of the leaf.

For temporary purposes, cadjan houses are frequently constructed, both by natives and Europeans. During the insurrection in the Kandyan country in 1818, almost all the sick were accommodated in cadjan hospitals. Except the frame work, every part of the house, walls, and roof, is formed of cocoa nut leaves, and they are capable of resisting all kinds of weather for a year or more.

To prevent thieving, the owners of topes frequently fix a cocoa nut leaf along the stems of the fruit trees. As the leaf rustles much when touched, a thief is cautious of ascending the trunk of the tree lest he should alarm some of the inmates of the neighbouring huts. Thunberg mistook the use of these leaves, and supposed that they supplied "the place of ladders, by means of which the natives could climb up and gather the fruit."

In warm climates it is customary to travel during night, with the view of avoiding the influence of an ardent sun. Torches then become necessary, and cocoa nut leaves are chiefly employed for this purpose. By tying the leaflets close to the centre rib of a leaf, the ignition is prevented from being too rapid. Torches of cocoa nut leaves, commonly denominated *chœls*, *(ooloo attu*, Singhalese), are in constant use, to obstruct the inroads of wild beasts upon cultivated fields, more particularly of elephants. In the interior of Ceylon, every field under cultivation must be watched during night, to prevent the depredations which would be made upon the crops, were these animals to have free ingress. When burned, the cocoa nut tree, especially the leaves, affords a large proportion of potash, whence the washermen procure all the potash they require by the incineration of different parts of the tree. Soap is very little used by the native washermen in Ceylon.

Boats are rowed with the centre rib of the leaf, in which operation it forms a substitute for paddles. The end of this part of the leaf, when well bruised, and thereby cónverted into a brush, is used for a variety of purposes, such as whitewashing houses, &c.

In British Guiana, the natives make a species of Æolian harp of the stipe of the leaf of a cocoa nut tree; and some tribes split the stipes, and after rendering the slit portions very thin, they are attached together laterally by means of their silky grass, thereby forming a sail for canoes.

Flower and Fruit. The *spaths*, or fibrous covering of the blossoms, are inflammable; on that account they are often employed as torches; and in some parts of India they are soaked in water, and converted into coarse cordage, with which the thatch of houses is tied. In the South sea islands it is employed in a green state by females as an apron, or substitute for a petticoat.

Many useful products are derived from the flower and fruit of this tree. By a peculiar manipulation the flower yields a rich saccharine juice, which is convertible into arrack or sugar. The word *arrack*, *arak*, *rack*, is probably a corruption of the Arabic word *uruq* or *urak*, a general name for distilled spirits. *Uruq*, more or less corrupted, is employed along the northern coasts of Africa, including Egypt, over all Asia with its islands, and even in the north and eastern parts of Europe, to denominate spirits. *Raki* is made at Constantinople from the skin of grapes when the juice has been expressed for wine. It is rendered aromatic with angelica, and a portion

of gum mastich is dissolved in it. In the neighbourhood of Hermanstadt it is distilled from prunes. The *Rakia* of the coast of Dalmatia is also drawn from the husks of the grape, mixed with aromatics; and a similar word is employed by the mountain Tartars to distinguish an intoxicating liquor from sloes, dog-berries, elderberries, wild grapes, plums, &c. Arrack is also made from milk. "Ariki or Arki; this the Tartars and Calmucks call the brandy which they distil from mare's or cow's milk. They put the milk in raw ox-hides, sewn into bags, and then let it grow sour and thick. They afterwards shake it so long till a thick cream settles on it; this they take off and dry it in the sun, and treat their guests with it, and the sour milk they either drink or distil the said brandy from it. The sour milk which they drink they call *kumisse.*"—*(Stahlenburg's Account of Siberia and Tartary.)* From the very extended use of the corruption of the word *uruq*, designating ardent spirits, we may infer, that the art of distillation was discovered in Arabia, and thence disseminated over the old world.

Sweet juice is extracted from the unexpanded flower in the following manner: A man, in colloquial language called a "toddy drawer," cuts off the point of the spadix, and ties the stump firmly round with a ligature. It is then daily beaten with a stick, which operation is supposed to determine the sap to the wounded part. Under this management, the juice begins to flow in a few days from the cut surface of the flower, and is carefully collected in an earthen vessel, which is suspended from the spathe. A thin portion of the flower and spathe is sliced off daily, and the end of the stump is bound with a ligature. A good healthy blossom will give from two to four English pints of sweet juice daily, and some flowers will continue to yield juice for about four or five weeks. Hence there are frequently two spathes on one tree, yielding toddy at the same time.

The mode by which a toddy drawer ascends the tree is as follows: He takes the dried stem of a creeping plant, and forms it into a circle of about a foot diameter, into which he puts his feet. He then raises himself up a little on the stem of the tree, by means of his hands, and subsequently supports his whole weight upon the feet and the connecting ligature. By the alternate motion of his hands and feet, he reaches the top. The ordinary implements of a toddy drawer are, the shell of a large gourd, capable of containing several pints of sweet juice, and a broad knife, which he suspends to a belt tied round his waist. In Bombay, the stem is sometimes notched on each side, to enable the toddy drawer to ascend the tree. The more common mode of ascent is there performed by putting a piece of cloth loosely round the body of the toddy drawer and the trunk of the tree. Under these circumstances, he presses the soles of the feet close to the stem, while he at the same time raises the encircling band, and thereby gains the ascent of a few inches at a time.

But when it is intended to draw juice from a "tope" or cluster of trees, the toddy drawer connects the heads of a great number of trees, by means of the stems of creeping plants, of which a great many grow in Ceylon. In some districts, coir-rope is used in place of these creepers. The toddy drawer selects a tree of easy access, near to the centre of the tope, the trunk of which he surrounds with a number of bands made of some creepers, each at about a foot distance. He then ascends by means of these bands, and passes along, from tree to tree, upon the connecting stems, assisted by the horizontal leaves, collecting as he proceeds the sweet juice, which he pours into the shell of the gourd suspended from his waist, and conveys it to the ground by means of a line. The gourd is emptied by a person on the ground, and drawn up by the man on the tree to be filled.

Juice is seldom drawn from a cocoa nut tope above six or seven months at a time, as this operation is supposed to exhaust the trees. During the intervening period, nuts are produced.

Toddy. This is the name given by the English to the sweet juices which are extracted from the different species of the palm tribe, including that of the cocoa nut tree. It is perhaps a corruption of *tari* or *taree*, the Mussulman name of the juice of the Palmyra palm, of which *tar* or *tal* is the Sanscrit name. *Ra*, which literally means juice, is the Singhalese name of the fluid extracted from the flower of a cocoa nut tree. Sometimes it is called *mee-ra* (honey or sweet juice), when prepared for making *jagery*. Among the inhabitants of the maritime provinces of Ceylon, it is frequently denominated *suri*, which is said to be a Sanscrit word. With the above explanation, the words *toddy*, *ra*, *mee-ra*, and *suri*, may be used synonymously. Fresh drawn juice is sweet, and has a peculiar flavour, in consequence of some extractive matter it contains; and, in general, it operates as a laxative. When it is intended to distil arrack from *suri*, the toddy drawers seldom change or clean the pots into which it is received, hence the juice soon ferments, and emits an acid smell. In a half-fermented state, suri is much relished by some Europeans. When it has become, by fermentation, highly intoxicating, the European soldiers, and the dissipated portion of the natives, drink it freely. To render this beverage acrid, the soldiers occasionally add green *chillies (Capsicum frutescens)* to it.

Is it not very probable that the "strong drink" mentioned in scripture was *mee-ra*, drawn from the flower or terminal bud of some of the palm

tribe, perhaps the date tree—palm wine. In several of the Oriental languages there appears to be an intimate connection between the words which designate honey, sugar, sweetness, and the juice of plants of the palm family. *Mee*, in the Singhalese language, means honey, sweet; and the toddy or juice extracted from palm trees is called *mee-ra.* Juice drawn from the flower of the sago palm, is by the Malays denominated *aer* (water) *saguer.* As the word *saguer* appears to be only a slight alteration from the Sanscrit adjective implying *sweet*, *aer saguer* will therefore literally mean *sweet water*, or the *sweetest water.* In the Javanese language, the juice of the gomuti palm is called *lagen*, which means the *sweet material* by distinction. We learn from Shaw, that the Hebrew word rendered *honey* in scripture, is by some commentators supposed to denominate the sweet juice procured from palm trees, as well as the honey of bees. He tells us that, in Barbary, the sweet juice extracted from date palms is called *dipse;* and that *dibse* or *dipse*, which is a Hebrew word, is generally translated *honey* in the Old Testament. Dr Moseley, in his Treatise upon Sugar, &c., says, that the strong drink of the scripture was called *shecar*, a word which likewise means *intoxication.* This word *shecar* does not differ much in enunciation from the Sanscrit adjective implying *sweet;* and it very closely resembles the Malay name of the intoxicating toddy of the sago palm *(aer saguer.)* Dr Moseley concludes his disquisition on the strong drink of the Old Testament by saying, "What sottish liquor *shecar* was, no person knows. It was probably made from grain, perhaps from honey. Our term *cyder*, which exclusively implies the fermented juice of apples, is supposed by Dr Clarke to be derived from the Hebrew word *shecar*, designating "*strong drink.*" St Jerome says, any intoxicating liquor obtains the denomination of *siker* or *shecar*, whether it be made of corn, apples, honey, dates, or fruits of any kind. *Shecar* seems to have become *sicera* (Latin), afterwards corrupted into *sidera*, hence *cyder.*

"It is usual for persons of respectability in Barbary to entertain their guests on festive occasions with the honey or *dipse* of the palm tree. This they procure by cutting off the head or crown of one of the more vigorous plants, and scooping the top of the trunk into the shape of a basin, where the sap in ascending lodges itself at the rate of three or four quarts a-day during the first week or fortnight; after this the quantity daily diminishes; and at the end of six weeks, or two months, the juices are entirely consumed; the tree becomes dry, and serves only for timber or fire-wood. This liquor, which has a more luscious sweetness than honey, is of the consistence of a thin syrup, but quickly grows tart and ropy, acquiring an intoxicating quality; and giving by distillation an agreeable spirit. This is called *Arâky* by the natives, and is the palm wine of the ancients."

The suri pots are sometimes visited, and the contents carried off during night. To detect the thief, the leaves of a species of datura are occasionally put into some of the pots. By means of the highly intoxicating effect of this compound, the marauder is often discovered. On the Coromandel coast the retailers of toddy sometimes rub the inside of the pots with the seed vessel or leaves of this highly poisonous plant, to increase the intoxicating influence of toddy.

Arrack may be distilled from suri the same day it is drawn; but sometimes this operation is delayed for a few days, without diminishing the quantity, or injuring the quality of the spirit. The process of distillation is carried on, in the maritime provinces, in copper stills; but, in the Kandyan provinces, earthen vessels are chiefly employed. Suri yields, by distillation, about one-eighth part of proof spirit. Arrack, when well prepared, is clear and transparent: generally, however, it is slightly straw-coloured. It has a peculiar flavour, no doubt depending upon an essential oil which rises from the suri during distillation. Many of the small distillers allow the toddy to run into acetous fermentation before the process of distillation commences, to which circumstance may be attributed the frequent existence of a small portion of acetic ether in the Ceylon arrack. Arrack is issued to the soldiers in India as part of the established ration; and the seamen belonging to the Royal Navy in the Indian seas are furnished with this spirit in place of rum.

Ceylon exports annually, and, for the most part to the presidencies of Bengal, Madras, and Bombay, from 5000 to 6000 leaguers of arrack, each containing 150 gallons. The custom duty on the exportation of arrack amounts to twenty per cent. *ad valorem;* and in 1813, the Madras government imposed an excise duty of 440 per cent. upon Ceylon manufactured spirits. The prime cost of arrack in Ceylon varies from 8d. to 10d. per gallon. It is stated by Mr Bartolacci, that arrack distilled at Batavia, is sold in India from ten to fifteen per cent. cheaper than that brought from Colombo, the Ceylon arrack being considered superior to the Javanese. In England, this spirit has brought as high a price as from five to six shillings per gallon.

Rajah Sri Wickreme Rajah, the king of Kandy, who was deposed in 1815, like his predecessors, prohibited the distillation of arrack in the interior of the island of Ceylon, except a small quantity, which was prepared in the royal laboratory, for the use of sick elephants belonging to the *maha vihare*, or great temple, and to be employed in the manufacture of gunpowder. Spirits is a favourite remedy in India for ele-

phants and horses, when they are supposed to be sick. From the number of empty cherry-brandy bottles found in the king's palace, when the British troops captured Kandy, it was inferred that he occasionally indulged in the use of spirits, when they were so far disguised or medicated as to enable him to escape the scandal of his subjects.

Batavian arrack is made from a mixture of molasses, palm-wine, and rice, in the following proportions:

Molasses, . . .	62 parts.
Toddy (palm-wine .	3 ditto.
Rice, ...	35 ditto.

100 parts of these materials yield 23½ of distilled proof arrack.

The rice is first boiled; after cooling, a quantity of yeast is added to it, and pressed into baskets. In this condition, it is then placed over a tub or tubs, for eight days, during which time a liquor flows abundantly from the mixture. At the end of that time, the liquor which has subsided is added to a mixture of molasses and palm-wine. The mixture remains in a small vessel for one day only, when it is removed into large fermenting vats, in which it remains for seven. The liquor is finally removed into the still; and, according to the number of distillations it undergoes, becomes arrack of the first, second, or third quality in commerce. The above account of the preparation of arrack is extracted from Mr Crawfurd's work on the Indian Archipelago. Mr Marsden informs us, that the "palm-wine" used in this kind of arrack is obtained from the cocoa nut tree, and that arrack of the first quality may be purchased for about sixty Spanish dollars; second for fifty; and the third for thirty, each leaguer of 160 gallons. At this rate, the best arrack may be procured for 20d. per gallon. It is at present manufactured chiefly for domestic consumption.

The phrase "pariah-arrack" is often used to designate a spirit distilled in the peninsula of India, which is said to be often rendered unwholesome, by an admixture of *ganja (cannabis sativa)*, and a species of *datura*, with the intention of increasing its intoxicating quality. It is not clear, whether the term pariah-arrack be colloquially employed to designate an inferior spirit, or an adulterated compound. This liquor is sometimes distilled from cocoa nut toddy, and at other times from a mixture of jagery, water, and the barks of various trees. The chief of the barks so used are those of the *mimosa ferruginea*, and the *phœnix spec.* The bark of the *mimosa leucophlea* is employed for a similar purpose.

Suri is the yeast commonly used by bakers in Ceylon. By allowing it to pass into the acetous fermentation, an excellent vinegar is obtained A great variety of vegetable substances are pickled with vinegar of this kind.

When it is intended to extract jagery from suri, great care is taken to prevent it from fermenting. Jagery is perhaps a corruption of the Singhalese word Hackarur or Sackarur, the H and S being often used indiscriminately in that language. A Sanscrit scholar has suggested, that sugar may be derived from the word *goor* (*sweet*,) the superlative of which is *segoor*, sweetest, hence very probably is the origin of the Arabian word *sukkar*. The earthenware pot into which the suri is received is emptied twice or thrice in twenty-four hours. After this operation, the pot is always well cleaned, then dried, and a small quantity of *chunam* (lime) is thrown into it, before being replaced. Sometimes a portion of the bark of a tree, whose name I do not recollect, is introduced into the receiving vessel, instead of chunam. The lime perhaps contributes to check the progress of fermentation. Almost immediately after the *mee-ra* is drawn from the tree, it is filtered through a portion of the reticulated substance found at the base of the leaf.

The juice is then slowly boiled in an earthen vessel, until it becomes light-coloured, and acquires a considerable degree of consistency. While still warm, and semifluid, it is poured into sections of cocoa nut shells, where it soon becomes solid. Twenty-four ounces of jagery may be procured from a gallon of *mee-ra*. I state the quantity of jagery which *mee-ra* yields, on the authority of Mr Bartolacci, who paid much attention to this subject. Forbes, in his Oriental Memoirs, says, that three quarts of tari (toddy,) when boiled down, will yield a pound of sugar,—a proportion not materially different from that given by Mr Bartolacci. It would appear that *mee-ra* is richer in saccharine matter than juice expressed from the sugar-cane in the West Indies. Dr Moseley, in his History of Sugar, says, "we consider a pound of sugar from a gallon of cane-juice as good yielding." According to Mr Crawfurd, cane-juice in Java yields, on an average, twenty-five per cent. of sugar. Jagery contains both the crystallizable portion of the juice, and a quantity of molasses or liquid sugar; but, by a subsequent operation, they can be, in a great measure, separated. This coarse sugar is generally made into little loaves, having the shape of a hemispherical vase, from the form of the vessel in which it cools. It has a deep chocolate colour; and, when broken, presents many clear shining particles of sugar. In the Malay language, jagery is denominated *goola* or *goora itan* (black sugar or black sweet).

The ordinary price of jagery is about 2d. per pound. It is the only sugar used by the native inhabitants, and no other is prepared in Ceylon. They enjoy the juice of the sugar-cane, by masticating the green shoots, but in no other way, al-

though they have a name for sugar extracted in other countries from that plant, which is *since* or *chinee*. The common soldiers ordinarily use jagery; and many Europeans of the upper ranks prefer it for sweetening coffee. Sugar-candy, which is chiefly imported from China, is the saccharine substance commonly used by the richer classes of Europeans in India. In some parts of the interior of Ceylon, particularly in the vicinity of Adam's Peak, great numbers of the inhabitants support themselves by extracting a sweet juice from the nepery tree *(Caryota urens,)* and manufacturing it into jagery. This tree grows spontaneously in the woods. The people thus employed, subsist chiefly upon coarse sugar. They occasionally procure a little rice and salt by barter, but they do not raise grain by cultivating the soil.

There is some foundation for supposing, that the sugar of the ancients, which seems to have been imported from India, was the produce of the palm family of plants, and not that of the sugar-cane. Salmasius, the commentator of Pliny, is decidedly of opinion, that the sugar of the moderns is the produce of a different plant from that which produced the sugar of the Greeks and Romans. All authors on this subject describe the sugar of the ancients as being of a very coarse quality, and mixed with a large portion of molasses, exactly resembling *jagery*, the produce of some of the palms. Virey, in his account of sugar, says expressly, that, "le premier sucre apporté des Indes n'etoit qu'une *moscouade (sucre brut.)*" And, in an essay upon the History of the Commerce of Venice, it is stated, that the sugar which was manufactured in Sicily, as early as 1173, brought a higher price than that which they imported from Egypt or from India, by the way of the Red sea. The extraction of sugar from the sugar-cane is much more operose than from the juice afforded by palms; and this may be one reason why palm-sugar should be more early known than cane-sugar, even in countries where the sugar cane is indigenous.

Among the articles of commerce which the Venetians imported from Asia, about the year 996, sugar is mentioned; but whether it was the produce of palm trees, or of the sugar-cane, cannot be satisfactorily ascertained. It is the opinion of Mr Marsden, that the sugar of the ancients was procured from palms. In his history of Sumatra he says, "If the ancients were acquainted with sugar, it was produced from some species of the palms, as the sugar-cane was not brought into the Mediterranean from the coast, till a short time before the discovery of the passage to India by the Cape. The word *saccharum* is conjectured to be derived from *jaggree*, which the French pronounce *schagaree*." His opinion is corroborated by Mr Crawfurd, who informs us, that, "although the cane be a native of the Indian islands, the art of manufacturing sugar from it is certainly a foreign art. There is no name for sugar in any dialect of the Indian islands, but a foreign one *gula, (perhaps a corruption of* goor *sweet;)* and this foreign one is pure Sanscrit. When Europeans first became acquainted with the natives of these islands, they found them ignorant of the manufacture of sugar from the cane. The Hindoo word *gula (sometimes written* gour) is indeed equally applicable to palm sugar as to that of the cane. It may be supposed therefore that the Hindoos instructed the Indian islanders only in the simple process of manufacturing the former, and that the manufacture of the latter was introduced by the Chinese, under the auspices chiefly of Europeans and in times comparatively very recent." Humboldt however infers, from some Chinese paintings which he saw at Lima, representing the different processes for extracting sugar, that this art is extremely ancient in that country.

Lime, to which a small quantity of jagery is added, takes on a very fine polish. Walls are prepared for receiving this covering, by wetting them with a strong infusion of the husk of unripe cocoas; and the same kind of fluid is used for mixing and tempering the materials. In Madras, and some other parts of India, the flat tops of the houses are covered with this cement. It is much employed to cover columns, as also to form the floors of rooms. Floors of this kind are sometimes stained and made to resemble the finest marble. It is said that jagery-cement has succeeded very well in Holland. In 1813, Ceylon exported jagery to the value of 39,245 rix dollars. The Ceylon rix-dollar at par was then equal to 1s. 9d. Sterling.

When the flower has not been injured, the tree bears nuts which are converted to many useful purposes. In some parts of India the cocoa nut is a symbol of matrimonial alliance. Young cocoa nuts are much used by the natives as an article of diet. During the unripe state of the fruit, the shell is lined with a pulpy substance, while the centre is filled with an aqueous fluid. This fluid is at first slightly astringent and sub-acid; as the fruit ripens, it becomes sweetish, and not unlike the colour and consistence of the whey of milk. When drunk before the sun has far advanced, it is much cooler than the atmosphere, and is then a pleasant beverage. Natives, particularly when travelling, generally furnish themselves with a few unripe nuts *(lanias*, Portuguese,) the water of which they drink, and eat the pulpy portion or kernel. Upon a few repasts of this kind, a man will labour from morning till night, without any other article of diet. The native inhabitants of the coasts of some of the islands in the equinoctial zone, are more palmivorous than granivorous. Where a people can be satisfied with food so easily pro-

2 I

cured as the produce of the cocoa nut tree, is in some tropical regions, they are little sensible to the ordinary motives which impel mankind to labour. The Reverend Mr Cordiner says, and perhaps with truth, that the person who possesses a garden with twelve cocoa trees and two jack trees, has no call to make any exertion. In Sumatra the annual produce of a cocoa nut tree is commonly estimated to be worth a Spanish dollar.

The husk or fibrous pericarp of the nut is employed to polish furniture, and to scour the floors of rooms, &c. Birds which build pendulous nests commonly construct them of this substance. Its chief use, however, is in the manufacture of *coir*, and for this purpose the nut ought not to be completely ripe. The word *coir* seems to be derived from the Latin vocable, *corium*, the skin. To remove the husk, an iron spike, or sharp piece of hard wood, is fixed in the ground; the nut is then forced upon the point, which passes through the fibres, thereby separating the rind from the shell. In this manner a man can clear 1000 nuts daily. *Coir* is prepared by soaking the rind in water for several months, like flax, and then beating it upon a stone with a piece of heavy wood. On the coast of America, when a running stream of water is not near at hand, the coir-manufacturers dig holes in the sand below high-water mark, and bury the rind of the cocoa nut before beating it. Subsequently it is rubbed with the hand until the interstitial substance be completely separated from the fibrous portion of the husk. The rind of forty cocoas furnished Mr Koster with six pounds weight of coir. The next operation is to twist the fibres into yarns, which are manufactured into cordage of all sizes. Coir is remarkably buoyant, and well suited for ropes of a large diameter. Until chain-cables were introduced, all the ships which navigated the Indian seas had cables made of this substance. Sea water is said to be rather beneficial than hurtful to it. Coir-cordage, when properly prepared, is pliable, smooth, strong, and elastic: it is very well suited for running-rigging, more especially where lightness is deemed an advantage, such as top-gallant studding-sail sheets, &c. On account of its elasticity, seamen consider it not well fitted for standing rigging. Dr Roxburgh, in his observations on the comparative strength of English hemp and other vegetable fibres, states, that he found hemp-rope and coir-rope, when large, to be respectively as 108 to eighty-seven in strength, and when smaller, as sixty-five is to sixty. In the same paper (Transactions of the Society of Arts, Vol. ii.) he says, "Coir is certainly the very best material yet known for cables, on account of its great elasticity and strength."

The natives sew the planks together which compose their boats with coir-yarns. When twisted into yarns adapted for being manufactured into cordage, it is valued in Ceylon at about £2 per candy (500 lb.) Large quantities of this substance are exported to the different ports in India. Under the Dutch government about 3,000,000 lb. were annually manufactured in the island. The quantity of coir exported from Ceylon in 1813, amounted to 4048½ candies, and each candy may be valued at twenty-eight rix dollars, total amount in rix dollars 137,649. Very lately a manufactory for the making of coir-cordage has been established upon a large scale at Recif, near to Pernambuco, on the coast of Brazil.

Coir is much used in India, in place of hair, to stuff matresses, cushions for couches, saddles, &c. It is also employed to make brooms and brushes to white-wash houses.

The kernel of the ripe cocoa nut is not unlike the substance of an almond either in taste or consistence. It is eaten by the natives, and frequently along with jagery. The natives of the Ladrone islands eat it in lieu of bread, with meat and fish. Sometimes it is rasped into very small pieces, and mixed with dressed rice, to give it a peculiar flavour; and occasionally it is pounded into meal, of which fritters and small cakes are made. In India this fruit is generally allowed to be very nutritious, and many suppose that it possesses the quality of inducing corpulence.

By a little pressure the kernel may be made to yield a white fluid resembling milk. When the milk of cows or buffaloes cannot be procured, Europeans sometimes add this liquid to tea as a substitute. Another substitute for milk may be obtained by rasping a kernel, and mixing the scrapings with some of the liquid contained in a nut. We are informed by Dr Pinckard, in his Notes on the West Indies, that puddings are made of cocoa-nuts in Barbadoes. A similar use is made of them in Ceylon. The kernel is sometimes pressed with honey and sugar, and used to make preserves.

When mature, the nut is much used in Ceylon, to furnish an oleaginous fluid required to prepare a dish in very general use among all ranks and classes in India, which is named *Cathy* in the Singhalese and Malabar languages, Anglicè *Curry*. This word is probably derived from the Hindoostanee vocable *Qurmoo* to stew. For this purpose the kernel is finely rasped by means of an iron instrument called *hiramana*, which resembles the rowel of a spur, the raspings are washed with a small quantity of water, and subsequently filtered. The emulsion thus formed is boiled along with the meat, fish, or vegetable substance intended to be "curried," and thereby supplies the oily fluid necessary in the composition of curry. A due proportion of spices is added to the mixture before it is re-

moved from the fire. When cocoa nuts cannot be procured, *ghee*, (clarified butter) is used as a substitute in the preparation of this delicious dish. In Bengal, and, I believe, over great part of the peninsula of India, curry is chiefly prepared by frying the meat with butter or ghee. The Ceylon or cocoa nut curry possesses much of the flavour of the nut; it has a light-yellow colour, and is easily digested, the oily part of the mixture being seldom too abundant.

But the chief product of the kernel of the cocoa nut is an excellent oil: and, to extract it, two different processes are employed; namely, decoction and expression. When the former process is followed, the fresh kernel is finely rasped; the raspings are next washed with water, which assumes a milky appearance; and, by decoction, yields a limpid oil. If the emulsion be exposed for a night, it separates spontaneously into an oily and a watery portion, and the oily part is purified by a very short boiling. To separate the oil, the operator, who is generally a female, lays the palm of her left hand flat upon the surface of the fluid; a portion of oil adheres to the hand, which is brushed off into a vessel by the right hand. The oil made in this manner is nearly as colourless as water, and when newly prepared does not smell offensively. In the course of a few days, particularly if exposed to the atmosphere, it emits a disagreeable odour. On an average ten nuts are stated by Mr Bartolacci to yield about a quart of oil; but Koster, who made the experiment, says, that thirty-two nuts rendered him only 3 lb. of pure oil.

Compression is the process chiefly adopted when cocoa nut oil is prepared in the large way. After clearing the nut of the husk, the kernel is exposed, which is effected by breaking the shell with a crooked knife,—an operation which is generally performed by one stroke. A large portion of the watery part of the kernel is dissipated by exposing it to the sun for a few days, during which period it acquires a considerable degree of rancidity. In this state the kernel is called *copra* or *copperas*. The oil is extracted from copra by grinding it in a very clumsy mill, which is worked by bullocks. Oil has for some years past been extracted by government from copra in large quantities at Colombo, by means of a steam-engine. The value of copperas exported from Ceylon, in 1813, amounted to 27,975 rix dollars.

The substance which remains after the oil has been extracted from *copra* is called pohak, which serves well to feed pigs, poultry, &c.

Ceylon exports annually a great quantity of cocoa nuts, chiefly to India. In 1809, the number amounted to 2,977,275. The medium price may be stated at about 3s. 6d. per hundred, or nearly one halfpenny a-piece. According to Koster, the value of cocoa nuts in Brazil is about 5s. 6d. per hundred, or a little more than $\frac{6}{10}$ths of a penny each. In Ceylon they pay an export duty of five per cent. These nuts are sometimes brought to this country from the West Indies. The captains of ships use them instead of wedges of timber, to fill up the vacuities between the casks and other packages which compose their cargoes. On this account the freightage of the nuts adds little to their original price. Cocoa nut oil may be exported at the rate of one shilling per gallon; and, at this price, a large quantity is annually sent to different parts of India. In Java, where it is an article of importation, the market price is usually about six Spanish dollars a-picul, which is equal to about 1s. 9d. per gallon. Within these few years, it has been imported into Great Britain, where the same quantity has been sold as high as from 5s. to 6s. The quantity exported from Ceylon, in 1813 amounted to 27,265 measures, each measure about two pints; value in rix dollars 7952.

In Ceylon this oil is universally used both by Europeans and the indigenous inhabitants, as a lamp oil. The natives burn it in a section of the cocoa nut shell, or in a small earthen vessel. Some of the upper ranks have brass lamps four or five feet high, which have several flat basons, with projecting beaks, affixed to a vertical stalk. The oil is introduced into the basons, the beaks of which are furnished with cotton-wick. Torches are prepared in Siam, by drying elephants' dung, soaking it in cocoa nut oil, and then covering the mass with long dry leaves tied at short distances, with shreds of bamboo. Mr Deville of the Strand, London, who has paid much attention to the illuminating qualities of different gases, says that the gas light from cocoa nut oil has so far the quality of day-light, that with it the difference between flowers of sulphur and wheat flour may be easily distinguished, which he was unable to do with any other artificial light. Cocoa nut oil is now manufactured into candles in this country, which closely resemble those made of wax, and for which they are a cheap and excellent substitute.

The Singhalese, and indeed a great proportion of the inhabitants of Asia, use considerable quantities of this oil, for the purpose of external inunction. It is not easy to ascertain precisely the benefits they expect to result from this practice. Some of the Orientals say, that inunction is used for the purpose of preserving their skins from the sun and wind. They sometimes anoint their bodies previously to going into the bath, probably for the purpose of diminishing the shock they might feel by a sudden reduction of the temperature of the skin: more commonly, however, the inunction takes place upon coming out of the water. The oil is applied with a considerable degree of friction; or, as Dampier des-

cribes the process, "chafing it for half an hour into hair and skin;" and the whole surface of the body, from the crown of the head to the soles of the feet, is generally anointed. It is perhaps more frequently applied to the hair of the head than to any other part of the body. I cannot, however, learn that they intend to destroy vermin by this means, although in all probability it may have such an effect. The Asiatics, without much exception as to rank, do not seem to consider this source of disquietude as either uncomfortable or disgraceful. Captain Lyon, who seems to have practised the inunction of oil, while in Northern Africa, says, "It is very refreshing, after a long day's journey to be well oiled over."

Cocoa nut oil is used as a substitute for olive oil, in the composition of pharmaceutical preparations, such as ointments, plasters, &c.; and it is found to succeed extremely well, except in the composition of plasters where a union is required to take place between oil and the semi-vitreous oxyde of lead. In the laboratory at Columbo, it is employed in a number of the preparations where olive oil is directed to be used by the different pharmacopœias. One of the editors of the Journal de Pharmacie, says, respecting cocoa nut oil, "J'ai aussi observé que cette huile divisait mieux le mercure qu'aucune autre huile végétale."—Tom. ii. p. 101.

Mixed with *dammer* (a species of resin) and the compound melted, a substance is formed which is much used in India to caulk the seams of boats and ships, in place of pitch. The same compound is employed to protect the corks of wine and beer bottles from the depredations of white ants.

In this country, it has been employed as a lamp oil, and in the manufacture of cloth, instead of olive oil. Soap is also made of it; and I am informed the glass-blowers prefer this oil to all others in their operations.

The following is a schedule of duties levied on the produce of the cocoa nut plantations in Ceylon, average of three years, 1827-8-9.

Distillery of Arrack, . .	£.3,644
Retail of Do. . . .	24,975
Export of Do. . . .	3,136
Export of Coir. . . .	153
Export of Jagery, . . .	162
Export of Copperas, . .	1,539
Export of cocoa nuts, . .	1,551
Export of cocoa nut oil, . .	413
	£35.573

Hitherto the importation of cocoa nut oil into Europe has been attended with much waste by leakage, in consequence of having been imported in casks, the wood of which permits the contents to transude in large quantities. Between the tropics, the temperature of the cabin or cuddy of a ship is frequently as high as from 83° to 86° Fahren.; that of the hold must be considerably higher. Cocoa nut oil does not freeze until the temperature be reduced to 73° Fahren. Hence it is in a fluid condition during a great part of the voyage from India.

The shells of cocoa nuts are manufactured into beads for rosaries. They are also used as drinking-vessels, and for various other domestic purposes. Occasionally they are polished by the natives, who cut figures in relief upon them. When thus ornamented, they are sometimes employed by the English as sugar-basins. In the neighbourhood of Monte Video, in South America, the ladies drink an infusion of an herb called *mate* (Paraguay tea) from highly ornamented cocoa nut cups. They extract the tea from the cup by sucking it through a long silver tube. The common ladle used in great part of India and in the Brazils, is formed of a part of a nut, to which a long wooden handle is fixed. In America they have even given a name to the instrument, for ladles made of silver are called *silver cocoas*. By the inhabitants of some of the oriental islands, they are employed as a measure for ascertaining the quantity of both dry and fluid substances. Their capacity is known by the number of *cowries* (Cyprea moneta) they will contain. Hence there are cocoas of 500 or 1000 cowries, and so on.

They are used as fuel by the Indian washermen to heat their smoothing-irons; and, when converted into charcoal, and mixed with lime, they are employed to colour the walls of houses.

As an article of the Materia Medica, the natives of India recommend a decoction of the roots of the cocoa tree, mixed with ginger, as an excellent febrifuge. The juice expressed from young branches, combined with oil, is said to be a useful application to piles. In chronic inflammation of the urinary organs they recommend a mixture of the expressed juice of the flower of the cocoa tree and sugar. The oil is said to be useful, if applied to ulcers or pustules on the head. Mixed with salt, and drunk to the quantity of eight ounces, it is said to expel worms from the intestines. Particular virtues have been attributed to cups made of the shell of the nut. They have been supposed to give an anti-apoplectic quality to intoxicating liquors. Many other virtues are ascribed to different parts of the tree, of which it is not necessary here to take notice.

When cocoa nuts are intended for seed, they are placed close to one another, with the holes uppermost, and covered with a small quantity of earth. In a short time, the aqueous fluid is absorbed, and the cavity becomes filled with a spongy-white substance. Through the largest of the three holes the plumula passes, and sometimes along with it the radicles, which run

downwards on the outside of the shell. The seedlings are allowed to remain in this state for about a year before they are transplanted. Holes of about two feet deep, and from twenty-five to thirty feet distant from each other, are dug in the field intended for a cocoa nut garden, and the young shoots put into them. Under each nut on the Malabar coast a fanum is placed. A little earth is put round the nut; and, in dry weather, the plants are watered. They require to be protected from cattle, and particularly from elephants.

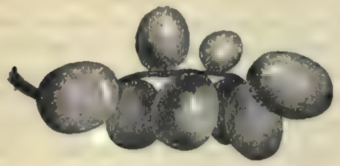
Double Cocoa Nut Palms. About eight or ten degrees north of Madagascar, lies a small group of islands called the *Seychelles*, which are rendered famous by the production of a palm not known in any other part of the world, and whose history is too remarkable to be passed over altogether in silence. Even of this small group of islands, three only, lying within half a mile of each other, produce the palm that bears the double cocoa nuts, or, as they are called, *cocos de mer*, from an erroneous idea that they were marine productions. Until the discovery of these islands in 1743, double cocoa nuts were only known from having been found floating on the surface of the sea in the Indian ocean, generally destitute of husk, and with the inner part decayed; but still so highly prized as to be spoken of by Rumphius as a "wonderful miracle of nature, the most rare of marine productions." This author further assures us that the double cocoa nut is no terrestrial production that may have fallen in the sea, and there become petrified, as others ignorantly stated; but "a fruit growing itself in the sea, whose tree has hitherto been concealed from the eye of man." The Malays asserted that the palm that bore it was sometimes seen at the bottom of the ocean, but that if dived for it instantly vanished; while the negro priests further affirmed that its submarine branches harboured an enormous griffin, which nightly came to shore, and, seizing elephants and tigers, carried them off to its nest as a prey; and not satisfied with those, attracted such ships as came near to the spot, and devoured the luckless mariners. With such, and even stranger ideas respecting its place of growth and history, there is no wonder that this nut should be highly prized in the Maldivian islands: it was death to any man to possess it, and all that were found belonged to the king, who sold them at high prices, or distributed them as regal gifts. From 120 to 150 crowns were paid for each nut; and even kings have been so greedy of obtaining these fruits, as to give a loaded ship for one. Rumphius certainly states his suspicions, that the Chinese and Malays may have perhaps set too high a value on the double cocoa nut, when considering it an antidote against all poisons. The albumen, or meat, which lines the nut, was thought to be the part where this virtue resided; it was mingled with red coral, black ebony, stag's horns, and many such anomalous ingredients, and drank from vessels of porphyry. All inflammations of the body were likewise believed to be subjected to its powers. It was a preservative against colic, apoplexy, paralysis, &c. The shell being less precious, was granted to the great men for drinking-vessels; a single slice being sufficient, if used as the lid, to neutralize the effect of any noxious ingredient that might mingle with the drink. The discovery of the Seychelles islands, and the knowledge thus obtained, that these mystical nuts grew upon trees, caused a speedy reduction in their value, though the botanical history of the palm that produced them, continued long a desideratum. Some imperfect notices served but to stimulate the curiosity that was finally gratified by Mr Telfair, who entreated Mr Harrison, a freed resident in the Seychelles, to obtain the necessary species and delineations. "To behold these trees," says Mr Harrison, "growing in thousands close to each other, the sexes intermingled; a numerous offspring starting up on all sides sheltered by the parent plants, the old ones fallen into the sear and yellow leaf, and going fast to decay to make room for the young trees, presented to my eyes a picture so mild and pleasing, that it was difficult not to look upon them as animated objects, capable of enjoyment, and sensible of their condition. A new leaf is formed annually, which, falling off at the year's end, leaves a scar or ring; by counting the number of which, it is estimated that this palm requires 130 years for its full growth. The foliage is finest on young plants shooting up perpendicularly, folded close like a fan, to ten feet or more. In this state it is pale yellow, and is used for hats and bonnets, afterwards it expands in all its beauty, and becomes green. The crown or cabbage in the midst of the leaves is eaten, the trunk is used for building, and the foliage serves for thatching, and even for the walls of houses; a hundred leaves sufficing to construct a house, including the partitions, doors, and windows. The down attached to the young foliage serves for filling mattresses and pillows, while the ribs of the leaves make baskets and brooms. Vessels of different forms and uses are made out of the nut, some of them holding six or eight pints; and being very strong and durable, they are much valued. Among other articles, shaving dishes, black, beautifully polished, set in silver, and carved, are formed of these nuts.

The Date *(phœnix dactylifera.)* Next to the cocoa nut, the date is unquestionably the most interesting and useful of the palm tribe. It is of the class *Diœcia;* order *Triandria* of Linnæus.

The date palm, though some of the family are more majestic, is still a beautiful tree. The stem of it shoots up in one cylindrical column, to the height of fifty or sixty feet, without

branch or division, and of the same thickness throughout its whole length. When it attains

103.



Date Fruit.

this height, its diameter is from a foot to eighteen inches. From the summit of this majestic trunk it throws out a magnificent crown of leaves, which are equally graceful in their formation and their arrangement. The main stems of the leaves are from eight to twelve feet long, firm, shining, and tapering; and each embraces, at its insertion, a considerable part of the trunk. The trunk of the palm is, in fact, made up of the remains of leaves, the ends of which are prominent just under the crown, but more obliterated toward the root of the tree. The bottoms of the leaves are enveloped in membranous sheaths, or fringed with very tough fibrous matter. These leaves are pinnated, or in the form of feathers, each leaf being composed of a great number of long, narrow leaflets, which are alternate, and of a bright lively green. Near the base of the leaf, these leaflets are often three feet long; but even then they are not one inch in breadth; neither do they open flat, but remain with a ridge in the middle, something like the keel of a boat. When the leaves are young they are twisted together, and matted up with loose fibres, which open and disperse as the leaf expands. The young leaflet is also armed at the extremity with a hard black spine, or thorn. They are more stiff and firm than the leaves of any other tree.

The trunk of the palm, though it is in some parts remarkably hard and durable, can hardly be considered as timber. It consists of longitudinal fibres, which are not so much interwoven as those of the branching trees; but have their interstices filled with a sort of pith, or medullary substance, when young, that is near the top, where the young leaves are in the progress of formation. This medullary substance is a sort of sap; but in the older portions of the tree it consolidates, though it always remains granular, and, as is the case with the pith of trees, is as easily divided across as longitudinally. Generally speaking, the medullary part of the palm is much lighter in the colour than the fibrous part; and thus well consolidated palm trunks have a beautifully mottled appearance when cut across. The wood of the areca palm, or cabbage palm of South America, is sometimes used in ornamental furniture, under the name of cabbage wood; but it does not answer very well, as the ends of the fibres are too hard, and the medullary matter too soft, for holding glue. For the same reason, the surface is very difficult to polish, and cannot be preserved without varnish. The flowers come out in large bunches or spikes, from between the leaves; they are at first inclosed in a spatha or sheath, which opens to let them expand, and then shrivels and withers.

The date palm is a diœcious tree, having the male flowers in one plant, and the female, or fruiting ones, in another. The male flowers are considerably larger than the female; and the latter, instead of stamens, have in the centres of them, the rudiments of the dates, about the size of small peas.

The two distinct sexes of the date tree appear to have been known from the remotest antiquity, as they are noticed by all the ancients who describe the tree. It is not a little remarkable, that there is a difference in the fructification of the wild date and the cultivated, though both are precisely the same species. Wild dates impregnate themselves, but the cultivated ones do not, without the assistance of art. Theophrastus and Pliny mention this fact; and in every plantation of cultivated dates, one part of the labour of the cultivator consists in collecting the flowers of the male date, climbing to the top of the female with them, and dispersing the pollen on the germs of the dates. So essential is this operation, that though the male and female trees are growing in the same plantation, the crop fails if it be not performed. A very remarkable instance of this is related by Delisle, in his Egyptian Flora. The date trees in the neighbourhood of Cairo did not yield a crop in the year 1800. The French and Turkish troops having been fighting all over the country in the spring, field labour of every kind was suspended, and amongst the rest, the fecundation of the date. The female date trees put forth their bunches of flowers as usual, but not one of them ripened into edible fruit. The pollen of the male trees appears to have been scattered over the country by the winds; and, as it had not been sufficiently abundant for reaching the germs so as to ensure fructification, an almost universal failure was the consequence. The Persians, according to the elder Michaux, who travelled in the country, were more provident than the Egyptians. In a civil war, which was attended with all the ruinous effects of anarchy, the male date trees of a whole province were cut down by the invading troops, that the fructification of this necessary of life might be stopped. But the inhabitants, apprehending such a result, had been careful previously to gather the pollen, which they preserved in close vessels; and thus they were enabled to impregnate their trees when the country was freed from the destroying army. It is said

that the pollen had thus preserved its powers during nineteen years.

Pontanus, an Italian poet of the fifteenth century, gives a glowing description of a female date tree, which had stood lonely and barren, near Otranto, in Italy, until a favouring wind wafted toward it the pollen of a male that grew at a distance of fifteen leagues. Father Labat, in his account of America, relates a story of a date tree in the island of Martinico. There were palm trees of various other kinds in the island, but there was only one date tree, which grew near a convent. That tree produced fruit which was grateful enough to the taste: but when an increase of the number of the date trees was wanted not a single one would grow from the seed; and thus, after a number of unsuccessful trials, they were obliged to send to Africa for dates, the stones of which grew readily, and produced abundantly.

Hasselquist thus writes of the date palm from Alexandria, while on his travels through Egypt. "The first thing after my arrival here was to see the date tree, the ornament and a great part of the riches of this country. It had already blossomed; but I had nevertheless the pleasure of seeing how the Arabs assist its fecundation. and by that means secure to themselves a plentiful harvest of a vegetable which was so important to them, and known to them many centuries before any botanist dreamt of the difference of sexes in vegetables. The gardener informed me of this before I had time to inquire, and would show me, as a very curious thing, the male and female of the date tree; nor could he conceive how I, a Frank lately arrived, could know it before; for, says he, all who have yet come from Europe to see this country have regarded this relation either as a fable or a miracle. The Arab seeing me inclined to be farther informed, accompanied me and my French interpreter to a palm tree, which was very full of young fruit, and had by him been wedded or fecundated with the male when both were in blossom. This the Arabs do in the following manner: When the spadix has female flowers that come out of its spatha, they search on a tree that has male flowers, which they know by experience, for a spadix which has not yet bursted out of its spatha. This they open, take out the spadix, and cut it lengthwise in several pieces, but take care not to hurt the flowers. A piece of this spadix, with male flowers, they put lengthwise between the small branches of the spadix which hath female flowers, and then lay the leaf of a palm over the branches. In this situation I yet saw the greatest part of the spadices which bore their young fruit; but the male flowers which were put between were withered. The Arab, besides, gave me the following anecdotes: First, unless they in this manner wed and fecundate the date tree, it bears no fruit; secondly, they always take the precaution to preserve some unopened spatha, with male flowers, from one year to another. to be applied for this purpose in case the male flowers should miscarry or suffer damage; thirdly, if they permit the spadix of the male flowers to burst or come out, it becomes useless for fecundation; therefore the person who cultivates date trees must be careful to hit the right time of assisting the fecundation, which is almost the only nicety in their cultivation; fourthly, on opening the spatha, he finds all the male flowers full of a liquid, which resembles the finest dew; it is of a sweet and pleasant taste, resembling much the taste of fresh dates, but much more refined and aromatic; this was likewise confirmed by my interpreter, who had lived thirty-two years in Egypt, and therefore had opportunities enough of tasting both the nectar of the blossoms and the fresh dates.

"In Upper Egypt, many families subsist almost entirely on dates. In Lower Egypt they don't eat so many, rather choosing to sell them. The inhabitants here yearly sell a considerable quantity, which are chiefly carried to the towns in Turkey, for which reason we see dates exposed to sale in every town. The Egyptians make a conserve of the fresh dates, mixing them with sugar. This has an agreeable taste. The stones or kernels of the dates are hard as horn, and nobody would imagine that any animal would eat them; but the Egyptians break them, grind them on their hand-mills, and for want of better food, give them to their camels, which eat them. In Barbary they turn handsome beads for paternosters of these stones. Of the leaves they make baskets, or rather a kind of sheet bags, which are used in Turkey on journeys, and in their houses. In Egypt they make fly-flaps of them, convenient enough to drive away the numerous insects which incommode a man in this country. I have likewise seen brushes made of them, with which they clean their sofas and clothes. The hard boughs they use for fences round their gardens, and cages to keep their fowls in, with which they carry on a great traffic; they also use the boughs for several other things in husbandry instead of other wood, of which they are destitute. The trunk or stem is split up, and used as beams for building houses, or for firewood. They lay a whole tree across their cisterns, on which they wind the rope when they draw water. The integument which covers the tree between the boughs entirely resembles a web, and has threads which run perpendicularly and across: of this all the ropes used at the cisterns are made, as also the rigging of their smaller vessels. They reckon in Egypt that date trees afford a sequin annually of profit for each tree. It is common to see two, three, or four hundred fruit-bearing date trees all belonging to one

family; and we may sometimes see three or four thousand in the possession of one man, which, at the above rate, bring in a considerable revenue to their owner for the little spot of ground they occupy. A full grown date tree does not at most take up above four feet in diameter, so that they may be planted within eight feet of one another." The same learned traveller, in another place, writes, "About this time we daily eat ripe dates. In Europe we seem to envy the felicity of the people who enjoy these fruits. I confess they are good to taste once or twice; but though I have got over the age when such things please most, yet I would gladly give two bushels of dates for half a bushel of good Swedish apples, and am persuaded I should find thousands in Egypt ready to make the same exchange."*

Four or five months after the operation of fecundation has been performed, the dates begin to swell; and when they have attained nearly their full size, they are carefully tied to the base of the leaves, to prevent them from being beaten and bruised by the wind. If meant to be preserved, they are gathered a little before they are ripe; but when they are intended to be eaten fresh, they are allowed to ripen perfectly, in which state they are a very refreshing and agreeable fruit. Ripe dates cannot, however, be kept any length of time, or conveyed to any very great distance, without fermenting and becoming acid; and therefore those which are intended for storing up, or for being carried to a distant market, are dried in the sun upon mats. The dates which come to the European market from the Levant and Barbary are in this state; and the travellers in the desert often carry with them a little bag of dried dates, as their only or their chief subsistence during journeys of many hundred miles. In parts of the East, the dates that fall from the cultivated trees are left on the ground for the refreshment of the wayfaring man.

In the Hedjaz, the new fruit, called *ruteb*, comes in at the end of June, and lasts two months. The harvest of dates is expected with as much anxiety, and attended with as general rejoicing, as the vintage of the south of Europe. The crop sometimes fails, or is destroyed by locusts, and then a universal gloom overspreads the population. The people do not depend upon the new fruit alone; but during the ten months of the year when no ripe dates can be procured, their principal subsistence is the date-paste, called *adjoue*, which is prepared by pressing the fruit, when fully matured, into large baskets. "What is the price of dates at Mecca or Medina?" is always the first question asked by a Bedouin who meets a passenger on the road.

There is, indeed, hardly any part of the tree which is not serviceable to man, either as a necessary or a luxury. When the fruit is completely ripened, it will, by strong pressure, yield a delicious syrup, which serves for preserving dates and other fruits; or the fruit may be made into jellies and tarts. The stalks of the bunches of dates, hard as they are in their natural state, as well as the kernels, are softened by boiling, and in that condition are used for feeding cattle. Dates, with the addition of water, afford by distillation a very good ardent spirit, which, as it does not come within the prohibition of the Koran against wine, is much used in some of the Mahommedan countries, and answers the same purpose of false excitement as the brandy or the malt spirits of other nations. Palm wine is also made from the date: this is also without the statute of the Prophet. It is known in Egypt by the name of *lakhlsy*. It is the sap or juice of the tree, and can only be obtained by its destruction; so that such trees only as are unproductive are selected for obtaining it. The time chosen for this purpose is when the tree is in the most active state of vegetation. The crown is then cut off, and a cavity scooped in the top of the trunk. As the sap rises, it exudes into this cavity, at the rate of nearly a gallon a-day for the first two weeks; after which it gradually diminishes; and at the end of six weeks or two months it stops entirely, and the tree, which has become by the operation completely dry, is cut down for fire-wood, or for any other of the purposes to which the trunk of the palm is applied. When the juice first exudes from the tree, it is remarkably sweet; but it soon ferments and becomes vinous, with a certain degree of acidity. This juice may also be distilled into an ardent spirit, forming the genuine arrack, or rack, of the East. In Egypt and Arabia, the date trees that have become unproductive, through age or any other circumstance, are commonly disposed of in this manner. What is called the *cabbage* of the palm is esculent in many of the species, and in the date among others. The cabbage is a conical tuft in the centre of the crown of leaves, and is formed of the future leaves in their undeveloped state. When the outside is removed, this part of the date tree tastes very much like a fresh chestnut; but, like the palm-juice, it is costly, being obtained only by the destruction of the tree; and therefore it is not used except in those trees which are cut for the sake of the sap or juice.

The fibrous parts of the date tree are made into ropes, baskets, mats, and various other articles of domestic use; and so are the strings or stalks that bear the dates. The cordage of the ships navigating the Red sea is almost exclusively of the inner fibrous bark of the date tree. The trunk answers very well for posts, railings, and other coarse purposes; but it is not fit for being worked into planks, as the fibrous nature of it

* Travels in the Levant, in 1750.

makes it easily split lengthwise into threads. The medullary part is much more abundant and soft toward the centre of the tree than toward the circumference; and, therefore, when it is to be used as timber, the trunk is generally cleft in two down the middle, for the purpose of allowing the heart to dry and harden.

The medullary part of the date tree is partly farinaceous, and soluble in water; and a nutritious substance may be obtained from it, resembling in consistency the *sago* which is obtained from another kind of palm. In the proper date tree, however, it is small in quantity, and by no means good in quality. From another, and a much smaller species *(phœnix farinifera)*, which is a native of the East Indies, the supply is much more abundant. This farinaceous date tree grows upon the dry and sandy parts of the east or Coromandel coast of the peninsula of Hindoostan. It is a very low tree, or rather a great leafy bush, for the trunk is never above a foot and a half or two feet in height, and the leaves completely conceal it. This palm is of a much deeper green, and has the leaves much narrower, than those of the date. It fruits and flowers nearly in the same manner. The berries are about the size of kidney beans, and of a shining black; they have not much pulp, but what they have is sweet and mealy. In times of scarcity the natives of Hindoostan have recourse to the wood of this palm for food. When the stem is divested of the leaves, and of the brown fibrous matter with which their roots are enveloped, it is about eighteen inches long, and six in diameter where thickest. The outside of it consists of woody fibres, of a white colour, and very much matted together, and within these the farinaceous matter is contained. To obtain that, the natives split the trunk into longitudinal pieces, dry them, beat them in mortars, and then sift the mass to separate the fibres. After this, the farina is ready for being boiled into gruel, or *congee*, as it is called in India; but it is bitter, and far inferior to sago. It has, however, occasionally been of much use, and saved the lives of the people at times when famine has threatened them with destruction.

Even the leaves of the date palm have their uses; their great length and comparatively small breadth, and their toughness, render them very good materials for the construction of coarse ropes, baskets, panniers, and mats. On the continent of Europe, palm-branches are a regular article of trade; and the religious processions, both of Christians and Jews, in the greater part of Europe, are supplied from some palm-forests near the shores of the Gulf of Genoa.

The cultivation of the date tree is an object of high importance in the countries of the East. In the interior of Barbary, in great part of Egypt, in the more dry districts of Syria, and in Arabia, it is almost the sole subject of agriculture. In the valleys of the Hedjaz there are more than a hundred kinds of dates, each of which is peculiar to a district, and has its own peculiar virtues. Date trees pass from one person to another in the course of trade, and are sold by the single tree; and the price paid to a girl's father, on marrying her, often consists of date trees.

The palm is not wholly confined to the warmer latitudes, though in those only it matures its fruit. There are greenhouse specimens in many parts of England. Some of the more luxuriant parts of the province of Valencia, in the southeast of Spain, have very fine forests of date-palms, from which, as well as from the neighbourhood of Genoa, palm branches are exported. There are date palms upon the coast of Gallicia, near Ferrol and Corunna; but the fruit on them does not come to maturity. There is abundance of palms in the gardens of Naples; and they are still finer and more numerous in that part of Sicily in the neighbourhood of Palermo, which, from the fertility of its soil, and the variety and beauty of its productions, has the name of "the golden shell." They are also to be met with in some parts of the south of France, though they rarely, if ever, ripen their fruit in that country. There are, in particular, two very majestic specimens growing in the open air in the botanical garden at Toulon; but these, so far as we have heard, have not yet flowered. As greenhouse plants, with heat in the colder season, they have been introduced into England for about a century; and the celebrated Miller, of the botanical garden at Chelsea, is reported to have been the first cultivator. The Messrs. Loddiges, of Hackney, have palms of considerable height growing under glass; there are also some fine palms at the botanical garden at Kew, and a great variety of splendid specimens in the botanic garden of Edinburgh.

The date palm is a very slow-growing tree; and even in the soil and climate that are most congenial, old trees do not gain above a foot in height in five years, so that, supposing the increase uniform, the age of a tree, sixty feet high, cannot be less than three hundred years. Dr Shaw says, that the palm of Barbary usually falls about the latter end of its second century.

The date is one of those plants which, in the countries that are congenial to their growth, form the principal subsistence of man; and its locality is so peculiar, that it cannot, strictly speaking, be classed either with the fruits of the temperate climates or with those of the tropical. It holds a certain intermediate place, and is most abundant in regions where there are few other esculent vegetables to be found.

There is one district where, in consequence of the extreme aridity of the soil, and the want of moisture in the air, none of the cerealia will

grow; that district is the margin of the mighty desert which extends, with but few interruptions, from the shores of the Atlantic to the confines of Persia, an extent of nearly four thousand miles. The shores, the banks of the rivers, and every part of this region in which there is humidity, are exceedingly fertile; and with but unskilful culture, produce the most abundant crops and the choicest fruits. But along the verge of the desert, and in the smaller oases or isles, which here and there spot that wilderness of sand, the date palm is the only vegetable upon which man can subsist. The lofty summits of the mountains of Atlas form an effectual barrier to the humid winds from the sea. Accordingly, the richer vegetation extends only as far to the south of them as the courses of the streams that are fed by the mountain snows; and these streams are soon evaporated by the air, or absorbed by the thirsty soil. The more lowly vegetables on that soil are chiefly of a saline and succulent description, such as euphorbias, salsolas, and cactuses, which retain their own humidity in consequence of their smooth and close rinds, without much aid from external moisture; but their juices are in general too acrid, or too much impregnated with soda, for being of any use as food. Over these, the date palm raises its trunk and spreads its leaves, and is the sole vegetable monarch of the thirsty land. It is so abundant, and so unmixed with any thing else that can be considered as a tree, in the country between the states of Barbary and the desert, that this region is designated as the Land of Dates (Biledulgerid); and upon the last plain, as the desert is approached, the only objects that break the dull outline of the landscape, are the date palm and the tent of the Arab. The same tree accompanies the margin of the desert in all its sinuosities; in Tripoli, in Barca, along the valley of the Nile, in the north of Arabia, and in the south-east of Turkey.*

This region of the date has perhaps remained for a longer period unchanged in its inhabitants and its productions than any other portion of the world. The Ishmaelites, as described in scripture history, were but little different from the Bedouins of the present time; and the palm tree (which in ancient history invariably means the date) was of the same use, and held in the same esteem, as it is now. When the sacred writers wished to describe the majesty and the beauty of rectitude, they appealed to the palm as the fittest emblem which they could select. "He shall grow up and flourish like the palm tree," is the promise which the royal poet of Israel makes for the just.

Even among the followers of other faiths, the palm has always been the symbol held in the greatest veneration. It is recorded of Mahomet that, like the psalmist, he was accustomed to compare the virtuous and generous man to the date tree: "He stands erect before his Lord; in every action he follows the impulse received from above; and his whole life is devoted to the welfare of his fellow-creatures." The inhabitants of Medina, who possess the most extensive plantations of date trees, say that their prophet caused a tree at once to spring from the kernel at his command, and to stand before his admiring followers in mature fruitfulness and beauty. The Tamanaquas of South America have a tradition that the human race sprung again from the fruits of the palm, after the Mexican *age of water*. The usefulness of the tree has thus caused it to be the subject of universal veneration. In ancient times, and in modern, the palm has been the symbol of triumph. The Jews carry it on a solemn festival in commemoration of their fathers having gained possession of the promised land; † and the Christians in remembrance of that more glorious victory, when the Saviour rode into Jerusalem amid the jubilations and hosannahs of the people.

Indeed, the tree is not unworthy of those honours which mankind have in all ages bestowed upon it; for the great utility of the tree must have been the cause of those honours. Rearing its stem, and expanding its broad and beautiful shade where there is nothing else to shelter man from the burning rays of the sun, the palm tree is hailed by the wanderer in the desert with more pleasure than he hails any other tree in any other situation. Nor is it for its shade alone, or even for its fruit, that the palm is so desirable in that country; for, wherever a little clump of palms contrast their bright green with the red wilderness around, the traveller may in general be sure that he shall find a fountain ready to afford him its cooling water.

Nor is it only when standing alone in the desert that the palm is a majestic tree. Palms form the shade and the beauty of many of the tropical forests. Some of them are among the tallest of trees; and when the margin of a river is spoken of as more than usually delightful, we allude to its palmy side.

The *Daum Palm*, *(nucifera thebaica.)* This tree is much esteemed in the countries where it abounds. "A native of the desert," says M. Delile, "its shelter renders many places that would otherwise be totally waste, capable of cultivation." Many species of thorny sensitive plants, which rarely grow on the spots watered by the Nile, find an asylum under its shadow. They increase there, and spreading in the direction of the desert, limit its extent by augment-

* Library of Entertaining Knowledge.

† Judea was typified by the palm tree upon coins of Vespasian and Titus.

ing the productive districts. The trunk of the daum is composed of longitudinal, parallel fibres, similar to that of the date, but much stronger, and closer. It is cut into planks, which are used for doors in Upper Egypt. The fibres are black, and the intermediate pith is yellow. The leaves are used for making carpets, bags, and baskets of various kinds. The pulp of this fruit is pleasant to the taste, and would be much used for food if it were not for the numerous fibres with which it is mixed; still the inhabitants of Said or Upper Egypt do frequently eat it. The fruit is sold in large quantities, and very cheap, at Cairo, where it is rather considered as a useful medicine than an article of food. It tastes like gingerbread, and is much relished by the children. An infusion something like the drink made of steeped liquorice root, or the pods of the carob tree, is prepared from the fruit, which, before maturity, contains a clear and tasteless fluid: when ripe, the kernel becomes very hard, and fine beads for rosaries are made of it.

The *Taliput*, or *Palmyra Palm*, *(corypha umbraculifera.)* This species is a native of Ceylon, where it occurs among the mountains in the interior. It also grows in the Burman empire, and other parts of the East Indies. The leaves are eighteen feet or more in diameter. They are of a coriaceous texture when dried, capable of being folded, and again opened repeatedly like a fan. Hence the usual term of the Fan Palm. They readily receive an impression from any hard point. Advantage is taken of this property to use stripes of them, prepared in milk, instead of paper, to write upon which is one of the most important uses of this palm. Their ribs are of the texture of cane, which adds greatly to their strength. When cut at the extremities of the petioles they are said to be used to protect the heads of travellers and fighting men who have to force their way through the jungle. For this purpose only a portion of the leaf is used. The thicker part, which was attached to the petiole, is placed forward, and the sides hanging over the ears, a kind of wedge or inverted keel is formed, which forces the branches aside as the wearer pushes forward. All the books of importance in Pali, or Cingalese, in Ceylon, relative to the religion of Buddhoo, are written upon laminæ of these leaves. The Pali and Cingalese character is engraved upon stripes of them, with either a brass or an iron style. There are some of these books in Sir A. Johnston's collection, which are supposed to be between five and six hundred years old, and which are still very perfect. Two fine specimens of books written upon the leaves, now in the library of the Royal Asiatic Society, are invaluable. The one is a complete copy of the Pali book, called the Pansyapanas Jatakaya, written upon eleven hundred and seventy-two laminæ of the finest description. This book contains the whole moral and religious code of the Buddhists, and is so scarce that it was for some time believed there was no complete copy extant. Sir A. Johnston, when president of his Majesty's council in Ceylon, being, from the various benefits which he had conferred upon the priests of Buddhoo, much in their confidence, was allowed by them to have copies taken of all the different parts which were dispersed among the most celebrated temples in the island, and of them formed a complete book. The other is a very fine specimen of a Burmese volume on the Buddhoo religion, written upon laminæ of the taliput leaf, lacquered over, and beautifully gilt, which was sent to the president by the king of Ava, with some other books as the finest specimen he could give him of the manner in which the books in a royal library at Ava were written. The taliput leaf is used in the maritime provinces of Ceylon as a mark of distinction, each person being allowed to have a number of these leaves folded up as a fan, carried with him by his servant. It is also used in the Candian country, in the shape of a round flat umbrella upon a stick. It is farther used to make tents, and by the common people to shelter them from the rain, one leaf affording sufficient shelter for seven or eight persons. When about eighty years old, which is when it has attained its full growth, the flower spike bursts from its envelope with a loud report; it is then as white as ivory. In the course of fifteen or twenty months, it showers down its abundance of nuts; this effort to provide a numerous succession, proves fatal to the parent. Thus it presents the singular phenomena of a long-lived plant only blossoming once during its existence, when it dies, and in dying, like the fabled Phœnix, sheds the seeds of a future generation around it. The flower is occasionally thirty feet long. Mr Bennet, author of an Account of the Fishes of Ceylon, was present during several of these rare explosions. In times of great scarcity, the natives of India cut down this palm and extract the pith for food. It very much resembles sago in its qualities.

The blossoms have such a strong heavy smell, that the natives cut them down and destroy them when in the vicinity of their cottages. The fruit is round, and very hard, about the size of a cherry, and so abundant, that one tree will produce sufficient to plant a whole country. They are not edible.

The *Torypha caliera*, or *Taliera palm*, another similar species, is also a noble plant, the wood of which is of universal use throughout the northern provinces of India for roofing houses and other domestic purposes.

The *Dwarf Palm*, *(chamærops humilis,)* has already been alluded to as the only species which will endure the cold of the temperate zone. It is of small stature, and grows, though not very

luxuriantly, in some of the southern countries of Europe.

104.

Plantain.

The PLANTAIN *(musa paradisiaca)* is of considerable size; it rises with a herbaceous stalk, about five or six inches in diameter at the surface of the ground but tapering upwards to the height of fifteen or twenty feet. The leaves are in a cluster at the top; they are very large, being about six feet long and two feet broad: the middle rib is strong, but the rest of the leaf is tender, and apt to be torn by the wind. The leaves grow with great rapidity after the stalk has attained its proper height. The spike of flowers rises from the centre of the leaves to the height of about four feet. At first the flowers are inclosed in a sheath, but as they come to maturity, that drops off. The fruit is about an inch in diameter, eight or nine inches long, and bent a little on one side. As it ripens it turns yellow; and when ripe, it is filled with a pulp of a luscious sweet taste.

The BANANA (*musa sapientum*) yields a shorter and rounder fruit than the plantain; the stem is also different, that of the plantain being wholly green, while the banana is spotted with purple. The banana is not so luscious as the plantain, but it is more agreeable. Those brought to this country are gathered unripe, but upon being kept for some time, acquire a rich golden colour. The plant is very successfully cultivated in our conservatories, and often produces the fruit in perfection. The manilla plantain fibre is the produce of a species named *musa textilis*. The finer kinds are manufactured into textile fabrics.

Having thus observed the slight differences in these plants, we shall proceed to their general character—in which notice we shall confine ourselves to the use of the word banana.

The banana, unlike some others of the tribe, is not confined to any particular country of the torrid zone, but offers its produce indifferently to the inhabitants of equinoctial Asia and America, of tropical Africa, and of the islands of the Atlantic and Pacific oceans. Wherever the mean heat of the year exceeds 75° of Fahrenheit, the banana is one of the most important and interesting objects for the cultivation of man. All hot countries appear equally to favour the growth of its fruit; and it has even been cultivated in Cuba, in situations where the thermometer descends to 45° of Fahrenheit. Its produce is enormous; the banana, therefore, for an immense portion of mankind, is what wheat, barley, and rye are for the inhabitants of Western Asia and Europe, and what the numerous varieties of rice are for those of the countries beyond the Indus.

The banana is not known in an uncultivated state. The wildest tribes of South America, who depend upon this fruit for their subsistence, propagate the plant by suckers. Yet an all-bountiful Nature is, in this case, ready to diminish the labours of man, perhaps too ready for the proper development of his energies, both physical and moral. Eight or nine months after the sucker has been planted, the banana begins to form its clusters; and the fruit may be collected in the tenth and eleventh months. When the stalk is cut, the fruit of which has ripened, a sprout is put forth, which again bears fruit in three months. The whole labour of cultivation which is required for a plantation of bananas is to cut the stalks laden with ripe fruit, and to give the plants a slight nourishment, once or twice a year, by digging round the roots. A spot of a little more than a thousand square feet will contain from thirty to forty banana plants. A cluster of bananas, produced on a single plant, often contains from one hundred and sixty to one hundred and eighty fruits, and weighs from seventy to eighty pounds. But reckoning the weight of a cluster only at forty pounds, such a plantation would produce more than four thousand pounds of nutritive substance. M. Humboldt calculates that as thirty-three pounds of wheat and ninety-nine pounds of potatoes require the same space as that in which four thousand pounds of bananas are grown, the produce of bananas is consequently to that of wheat as 133 : 1, and to that of potatoes as 44 : 1.

The banana ripened in the hot-houses of Europe has an insipid taste; but yet the natives of both Indies, to many millions of whom it supplies their principal food, eat it with avidity, and are satisfied with the nourishment it affords. This fruit is a very sugary substance; and in warm countries the natives find such food not only satisfying for the moment, but permanently nutritive. Yet, weight for weight, the nutritive matter of the banana cannot at all be compared to that of wheat, or even of potatoes. At the same time, a much greater number of individuals may be supported upon the produce of a piece of ground planted with bananas, compared with a piece of the same size in Europe growing wheat. Humboldt estimates the proportion as twenty-five to one; and he illustrates the fact by remarking that a European, newly arrived in the torrid zone, is struck with nothing so much as the extreme smallness of the spots under cultivation round a cabin which contains a numerous family of Indians.

The ripe fruit of the banana is preserved, like the fig, by being dried in the sun. This dried banana is an agreeable and healthy aliment. Meal is extracted from the fruit, by cutting it

in slices, drying it in the sun, and then pounding it.

The facility with which the banana can be cultivated, observes a recent writer, has doubtless contributed to arrest the progress of improvement in tropical regions. In the new continent civilization first commenced on the mountains, in a soil of inferior fertility. Necessity awakens industry, and industry calls forth the intellectual powers of the human race. When these are developed, man does not sit in a cabin, gathering the fruits of his little patch of banana, asking no greater luxuries, and proposing no higher ends of life than to eat and to sleep. He subdues to his use all the treasures of the earth by his labour and his skill; and he carries his industry forward to its utmost limits, by the consideration that he has active duties to perform. The idleness of the poor Indian keeps him, where he has been for ages, little elevated above the inferior animal; the industry of the European, under his colder skies, and with a less fertile soil, has surrounded him with all the blessings of society, its comforts, its affections, its virtues, and its intellectual riches.

In a very interesting and instructive paper by Mr John Lindley, "on the Tropical Fruits likely to be worth cultivating in England," it is stated, upon the authority of Mr Crawford, that some of the varieties of the banana possess an exquisite flavour, surpassing the finest pear; and that others in the East Indies have been compared to an excellent rennet apple, after its sweetness has been condensed by keeping through the winter. Of these varieties there are so many, that they would be as difficult to describe as the sorts of apples and pears of Europe. The banana has frequently produced its bunches of yellow fruit in hot-houses in this kingdom; particularly at Wynnstay, the seat of Sir W. W. Wynn; and at Messrs. Loddiges', at Hackney; and, according to Mr Lindley, "it appears probable that there will be as little difficulty in ripening the fruit, as that of any tropical tree whatever."

Sago, *(sagus farinifera.)* This and some other species, all yielding the nutritious farina called sago, are natives of the south-east of Asia, and of the islands of the Indian ocean. The sago, or, as it is called in the Molucca islands, the libley tree, is of peculiar appearance. The trunk, which is formed of the bases of the leaves, grows at first very slowly, and is covered with thorns; so soon, however, as the stem is formed, the growth of the tree proceeds with great rapidity, so that it speedily attains its full height of thirty feet, with a circumference of five to six feet, losing in this stage its thorny accompaniments. Like the cocoa nut palm, the sago has no distinct bark that can be peeled off; but the trunk consists of a long, hard, ligneous tube, about two inches thick, the internal area of which is filled with a kind of farinaceous pith, intermixed with numerous longitudinal fibres. The maturity of the tree is known by the transpiration of a kind of whitish dust through the pores of the leaves, and when this appears, the trunk is felled near to the ground. Forrest, in his account of the Molucca islands, thus details the process of sago manufacture: "The tree being felled, is cut into lengths of five or six feet. A part of the hard wood is then sliced off, and the workman coming to the pith, cuts across the longitudinal fibres and the pith together, leaving a part at each end uncut. So that when it is excavated there remains a trough into which the pulp is again put, mixed with water, and beaten with a piece of wood. Then the fibres separated from the pulp float at top, and the flour subsides. After being cleared in this manner by several waters, the pulp is put into cylindrical baskets made of the leaves of the tree; and if it is to be kept some time, those baskets are generally sunk in fresh water to keep it moist. One tree will produce from two to four hundred weight of flour." We seldom see sago in Europe but in a granulated state. To bring it into this state from this flour, it must be first moistened and passed through a seive into a very shallow iron pot, held over a fire, which enables it to assume a globular form. Thus all our grained sago is half baked, and will keep long. The pulp or powder of which this is made, will also keep long if preserved from the air; but if exposed, it presently turns sour. Loaves of bread are sometimes made in the Molucca islands of sago flour, and baked in small ovens, the floors of which are divided, by means of partitions, into cells about the size of an octavo volume.

Sago has lately been used in this country, mixed with wheaten flour, for bread. In certain proportions it makes a very palatable bread; but if used in excess, the farina, of which it entirely consists, renders the bread heavy, and less digestible than wheaten flour alone. The sago palm affords a greater quantity of nourishing matter than any other, except the banana. As it grows spontaneously, and in great abundance in the Asiatic islands, a means of subsistence is thus afforded to the indolent natives, without much toil or ingenuity. The single trunk of a tree in its fifteenth year, sometimes furnishes six hundred pounds of sago. Mr Crawford has calculated in his History of the Indian Archipelago, that a single acre of land will support four hundred and thirty-five sago palms, which will annually produce 120,500 lbs. of sago.

The *Cycas cincinalis*, sometimes mentioned as the only sago plant, yields a very inferior kind.

The *Mauritia Palm*, which also yields sago, grows in great abundance on the banks of the Orinoco river, in South America. This whole country is subject to inundations; and the fan-

like branches of these trees, look like a forest rising out of the expanse of waters. The navigator who passes along the delta of the Orinoco, is surprised to see the tops of these trees lighted with fires. They are kindled by the Gaunchos, a people who have remained for ages in these marshes, secured from the floods by living in the palm trees. In the branches they suspend mats, which they fill with clay; and on this damp earth kindle the fires which are necessary for their comfort. Sir Walter Raleigh saw and described these people. The palm offers to this rude race, as well as to other tribes who inhabit the gulf of Darien, and the watery lands between the Guarapitha and the mouths of the Amazon, a safe habitation amidst the inundations to which those countries are subject. But it affords them also in its fruit, its farinaceous bark, its sap abounding with sugar, and its fibrous stalks, pleasant food to eat, wine to drink, and thread to make cordage and hammocks. "It is curious to behold," says Humboldt, "in the lowest stage of civilization, the existence of a whole race depending upon a single species of palm, in a similar degree with those insects which subsist upon one species of flower.

The Cabbage Palm (areca oleracea). This is one of the most beautiful and stately of the palm tribe, and hence, in some of the tropical islands, has received the name of the palmetto-royal. The stem, which, at its base, measures seven feet in circumference, ascends straight and tapering to a gigantic height. Logan mentions some of them, when the island of Barbadoes was first taken possession of by Europeans, as two hundred feet in height; but Mr Buges observes, that the highest in his time in the island was one hundred and thirty-four feet. "I am inclined to believe," says Bryan Edwards, "that I have seen them in Jamaica upwards of one hundred and fifty feet in height; but it is impossible to speak with certainty without an actual measurement." Near the base the trunk is of a brown colour, hard, woody, and jointed, with a pith inside like the elder. The upper part of the trunk, from whence the foliage springs, resembles a well turned finely polished baluster, of a lively green colour, gently swelling from its pedestal, and diminishing gradually to the top, where it expands into branches, waving like plumes of ostrich feathers. These are decorated with numerous leaflets, some of which are about three feet long, and an inch and a half broad, tapering into a sharp point. The leaflets gradually decrease in size as they approach the extremities of the branches. This lofty regular group of foliage, impelled by the most gentle gale, and constantly waving in feathery elegance, is an object of beauty which cannot be imagined by an inhabitant of temperate climes, unused to the magnificent vegetation of a tropical sun. The seed is enclosed in a brown spatha, which rises from the centre of the branches, and hanging downwards, consists of small oval nuts, not unlike a bunch of dried grapes, but much longer in proportion to their circumference. Within the leaves, which constitute the summit of the trunk, the portion called the cabbage lies concealed. This substance is white, about two feet long, of a cylindrical form, and the thickness of a man's arm. It is composed of longitudinal flakes like ribands, and so compact as to form a solid crisp body. When eaten raw, it tastes somewhat like the almond, but more tender and delicious. When cut into slices and boiled, it is served up with meat as a vegetable dish. To obtain this very small portion, growing on the very summit of such a stately trunk, the noble tree must be felled to the ground. In the place where the cabbage grew, a species of beetle very generally takes up its abode, and deposits its eggs, from which, in due time, grubs are hatched, that have received the name of palm tree worms. By the negroes these are reckoned a very great luxury; and Stedman thus gives an account of them in his History of Surinam: "Another negro also brought in a regale of *groe-groe*, or cabbage tree worms, as they are called in Surinam. This reptile grows to the size and thickness of a man's thumb, and is extremely fat. However disgusting to appearance, these worms are a delicious treat to many people, and they are regularly sold at Parameribo. The manner of dressing them is by frying them in a pan, with a very little butter and salt, or spiting them on a wooden skewer. In taste they partake of all the spices of India, as mace, cinnamon, cloves, nutmeg. Several species of these worms are produced in all the palm trees when beginning to rot; but some are larger than others. They are all of a pale yellow colour, with black heads."

Carnauba Palm (corypha cerifera). This palm is a native of Brazil, and grows in the low lands on the banks of rivers. It attains the height of thirty feet. The leaves are two feet in length, and, while young, are folded up like a fan; when expanded, they measure two feet in breadth. If they are cut from the tree when they have attained their full growth, and are placed to dry in the shade, a considerable quantity of light coloured scales is loosened from their surface. These scales, when subjected to a heat of 206° Fahrenheit, melt into a substance exactly resembling wax. It is of a pale yellow colour, and on cooling, becomes hard and brittle. Alcohol, unless heated, has not the power of dissolving this wax. Fixed oils, at the temperature of boiling water, cause its solution. Its specific gravity is .980. It possesses most of the properties of bees' wax, and can be formed into candles, which burn with a good and steady light. The addition of a tenth part of tallow

renders these candles less brittle, without imparting to them any unpleasant smell, or materially impairing the intensity of the light. Excellent candles are also made from a mixture of three parts of this wax and one part of common bees' wax. A quantity of the wax of this palm was sent to England from Rio de Janeiro, and subjected to a chemical analysis by Mr Brande. The result of these experiments was highly satisfactory as to its efficiency as a substitute for wax candles. We know not whether its employment for this purpose be still persevered in.

The leaves are not the only useful part of the carnauba palm. The green fruit, after being boiled in several waters, affords a nutritive food; the pith of the stem of the young plants, after being bruised in water, is likewise applied to the same purpose. The kernel of the fruit, when ripe, is covered with a layer of sweet pulp, and this is found to be wholesome food for cattle. The leaves make a very durable covering for houses, and in such service will sustain every vicissitude of weather for twenty years without requiring to be renewed. The trunk of the tree is a useful wood for building houses, making fences, and a variety of other purposes.

The Ceroxylon Andicola, another species of palm, also yields a substance somewhat resembling wax. This palm is a native of the Andes, towering in majestic beauty on mountains which rise many hundred toises above the level of the sea, approaching even to the verge of perpetual snow. Humboldt describes the tree as attaining to the prodigious height of one hundred and sixty feet, while it differs from all the other species of palms in flourishing under a much colder temperature. The trunk of the ceroxylon is covered with a peculiar kind of varnish, possessing some of the properties of wax. Vauquelin subjected this product to chemical analysis, and found that it contained two-thirds of resin and one-third of wax, thus differing materially from the inflammable substances obtained from the corypha.

Elæis Guineensis. This palm grows in various parts of Africa. It grows best in shady places, and attains the height of fifteen to sixteen feet. The fruit resembles the stone of the date. When ripe, this nut is heated by fermentation, and then coarsely pulverized in hollow cylinders, by which its oily matter is separated. It is then macerated in hot water, when the oil gradually collects on the surface, and cooling, concretes into a thick unctuous cake, of a light lemon colour, with little or no taste, but having a rich perfume. At the ordinary temperature of the air it is not a fluid oil. At 69° it begins to be slightly opaque; at 62° it is of the consistence of honey; at 45° it is proportionably thicker, but still retains a degree of softness. It is heavier than most of the other expressed oils. The quantity of oil in these nuts is very considerable, one gallon of nuts usually producing a quart of oil. This oil is used as butter by the natives of the Gold Coast, entering into all their culinary preparations; and when eaten fresh, is a delicate and wholesome article of diet, differing as much from the palm oil imported into England, as fresh butter does from that which is rancid. It is employed in this country to make a soap, which bears the name of palm soap; and also enters into the composition of other articles of perfumery. The quantity used for home consumption in 1830 was 160,000 cwt.

CHAP. XXIX.

THE YAM, ARROW ROOT, AND ALLIACEOUS PLANTS.

There are several plants belonging to the monocotyledonous division whose roots are serviceable to man as food, especially some of those which possess a farinaceous or starchy substance. Although none of these are equal in value to the potato, which will be described afterwards, yet there are a few which deserve notice as affording a considerable quantity of a farina as pure as that derived from the cerealia.

The Yam *(dioscorea sativa)*, belongs to the class *diœcia*, and order *hexandria* of Linnæus.

106.

Yams.

It is an herbaceous climbing plant, with a slender stalk, growing to the height of about twenty feet. The leaves have long foot stalks, and are smooth and sharp pointed. The flowers are small spikes, arising from the base of the leaf stalk. The roots are flat, either palmated, *a*, or irregular shaped, *b*, about twelve inches in diameter; externally of a dark brown colour, approaching to black; internally white.

The Winged Yam (dioscorea alata), is another species frequently cultivated. Its roots are much larger than the other, being frequently three feet long, and weighing about thirty pounds.

It is supposed that the yam was originally a native of the East Indies, and from thence was conveyed to the West India islands by the original settlers, for it is no where found growing in a natural state in these islands. On the Malabar coast, and in the island of Ceylon, on the contrary, it is a common indigenous plant, growing in the woods with great luxuriance. It is extensively cultivated in the tropical parts of the continents of Africa, Asia, and America, and is there an excellent substitute for the potatoe.

It is easily raised, is very productive, and resembles the potatoe in its qualities, only is of a closer texture. When dug out of the earth the roots are put for some time to dry in an airy place, and may afterwards be kept in casks or in sand for a long time. They are used either roasted or boiled, and form a substitute for bread.

Yams are raised from the cuttings of the roots, which are planted generally in August, and come to maturity in four or five months. Brown, in his account of the culture of this plant, mentions, that in dividing the roots for seed plants a portion of skin must be left on each piece, otherwise no germination will take place, for he says, that by this skin alone they germinate, the roots having no apparent buds or eyes, but they cast out their weakly stems from every part of the surface alike.

INDIAN ARROW ROOT (*Maranta arundinacea*).

.107

Arrow Root Plant.

This is an herbaceous perennial plant, of the class *monandria*, and order *monogynia* of Linnæus, and a native of the south of Africa. It grows to the height of two or three feet, has broad pointed leaves, and bears a spike of small white flowers. It is cultivated to some extent in the islands of the West Indies, and in parts of India, for the purpose of obtaining a farinaceous powder from its roots, well known as the substance called arrow root. This latter name it obtained from confounding it with another plant from which the Indians extract a poison with which they anoint their arrows. There are two species, the *maranta arundinacea* and *ramosissima*, which yield the arrow root. The process is as follows: When the roots are a year old they are dug up, and carefully washed in clean water. They are then either grated or beaten into a pulp, in a large wooden mortar. This pulp is then thrown into a quantity of clean water, and after thorough agitation, all the fibrous matter is collected with the hand, squeezed, and thrown out. The remaining milky fluid contains the farina, mixed with water, and a portion of the remaining fibrous matter. This latter is separated by straining through a sieve, when the liquid is then allowed to rest, the starch subsides to the bottom, and the water is drained off. The white pasty residuum is again washed in a farther portion of water, and allowed to subside as before; and this process is sometimes repeated a third time and even oftener, if a very fine powder is required. The powder is finally spread on clean white cloths, and dried in the sun; and in this state is fit for use, and will keep for any length of time, provided moisture is kept from it.

COMMON ARUM, or WAKE ROBIN (*arum maculatum*). This plant belongs to the class *monœcia*, and order *polyandria* of Linnæus. The root is perennial, tuberous, about the size of the thumb, sending off many long simple fibres. The leaves are commonly three or four, growing from each root; these are arrow-shaped, of a deep green or purplish colour, beset with many veins and dark spots, and stand upon long grooved and somewhat triangularly-shaped footstalks. The flower-stalk is very short and channel-shaped; the calyx is a sheaf of one leaf, large, oval, nerved, and enclosing the spadix, which is round, club-shaped, fleshy, above of a purple colour, below whitish, standing in the centre of the sheath, and supporting the parts necessary to fructification. On tracing it towards the base, we first discover the nectaries, or several oval corpuscles, which are terminated by long tapering points; next to them are placed the anthers, which are quadrangular, united, and of a purple colour; under them again we find more nectaries, and lastly the germina, which are very numerous, round, without styles, and crowned with small bearded stigmata. This curious species of inflorescence displays itself early in spring; but the berries do not ripen till late in the summer, when they appear in naked clusters, of a bright scarlet colour, making a conspicuous appearance under the hedges, where they commonly grow. The root, in its recent state, contains a milky juice, extremely acrimonious, and in this state it is used in medicine as a powerful stimulant. This acrimony is, however, dissipated by drying and by the application of heat, when the substance of the root then becomes a bland farinaceous matter, like arrow root. For this purpose it is either roasted or boiled, then dried and pounded in a mortar, the skin being previously peeled off. The powder is said to possess a saponaceous quality, and has been used for cleaning linen instead of soap. It forms also the *Cypress powder* of the Parisians, much used as a cosmetic for the skin.

108.

The Egyptian Arum (*arum colocasiæ*) abounds in Egypt, Syria, and the adjacent countries, and is extensively cultivated for the sake of its large esculent roots, which are no less esteemed than those of the other species of the same plant.

Taro (*arum esculentum*) is another species

cultivated in the Polynesian islands. The root requires to be planted in a hard soil, and kept covered with water from nine to fifteen months, when it is fit to eat, though it increases in size and excellence for two years more. In the natural state both the foliage and roots of taro have all the pungent acrid qualities that mark the genus to which the plant belongs; but these are so dissipated by cooking, whether baking or boiling, that they become mild and palatable, with no peculiar flavour more than belongs to good bread. The islanders bake the root in the native ovens in the same way as the bread fruit, and then beat the paste into a mass like dough, called *poe*. It is eaten by thrusting the forefinger of the right hand into the mass, and securing as much as will adhere to it, passing it into the mouth with a hasty revolving motion of the hand and finger.

GARLIC *(allium sativum)*. Several bulbous rooted plants belonging to the natural order *liliaceæ*, of which garlic is the type, have a peculiar pungency, which habit has rendered grateful as an article of food, or rather as an addition to other more insipid viands. Garlic belongs to the class *hexandria*, and order *monogynia* of Linnæus. The root is perennial, composed of several bulbs,

109.

Garlic.

enveloped in a common membrane, and from its base sends off many long white fibres. The stem is simple, and rises about a foot and a half in height; the leaves at the root are numerous, on the stem few; they are all long, flat, grass-like. The flowers of all the plants of this species arise between the small bulbs, or rocamboles, which terminate the stem in a cluster. Each flower is very small, whitish, and commonly abortive. The calyx is a spatha common to all the florets and bulbs; it is withered, and of a roundish shape. The corolla consists of six oblong petals. The filaments are six, tapering alternatêly, trifid, shorter than the corolla, and furnished with oblong erect antheræ. The germen is placed above the insertion of the corolla, short, angular, and supports a simple style, terminated by an acute stigma. The capsule is short, broad, trilobed, three-celled, three-valved, and contains roundish seeds. It flowers in July.

This species of garlic, according to Linnæus, grows spontaneously in Sicily; but as it is much used both for culinary and medicinal purposes, it has been long very generally cultivated in gardens. It shows the same propensity to forming bulbs, instead of flowers, as the rocambole garlic, which it also resembles in other respects. Every part of the plant, but especially the root, has a pungent acrimonious taste, and a peculiar rather offensive odour. This odour is extremely penetrating and diffusive, for on the root being taken into the stomach, the alliaceous scent impregnates the whole system, and is discoverable in the various excretions. This volatile matter is, in part at least, an essential oil, which may be obtained in distillation in the ordinary manner; and like the oils of many of the siliquose plants, sinks in water. Applied to the skin, garlic has the same effects as a blister. This plant was first cultivated in England in 1548. It is a hardy plant, and thrives best in a rich dry soil. There are three species of garlic which grow wild in Britain, the sand, the crow, and the leek garlic. The wild garlic of Kamchatka *(allium ursinum)* is eagerly gathered by the natives, and used with their food, and also as a medicine for the cure of scurvy.

THE ONION *(allium cepa)*. This is a biennial herbaceous plant, with long tubulated leaves, a swelling pithy stalk, thicker in the middle than at either end. The flowers are in the form of a large spherical head, which blow out the second summer after sowing. The root is in form of a series of concentric coats, varying in size according to the soil and climate, and also in colour, from a wine-red to white. The peculiar flavour is less intense or acrid than that of the garlic, and there is also more of a mucilaginous nutritive substance in the bulb. The flavour also varies much, according to the size of the bulb, the small reddish onions having much more pungency than the larger ones. There are at least twenty varieties of this plant.

The onion was known and cultivated at a very early period in Britain. It is not supposed that any variety of it is indigenous, since the large and mild roots which are imported from warmer climates deteriorate both in size and sweetness after having been cultivated a few years in this climate. The onion called the Strasburgh, and the varieties which have been obtained from it in this country, appear to be the most naturalized, as they are the hardiest which are grown.

2 L

It is, therefore, probable that this plant was first introduced into England from the central parts of continental Europe; although it may have been originally the native of countries farther to the south, and have been rendered hardier and less prone to degenerate from its gradual change of climate.

The onions of Spain and Portugal, and even those of the south of France, are very superior to the common onion of our gardens, being of a much larger size, and more mild and succulent. These sorts, however, will not bear the colder climate of this country without degenerating, while their seed seldom comes to maturity in Britain.

Though the history of the onion can be but imperfectly traced in Europe, there is no doubt as to its great antiquity in Africa, since there is evidence to show that this bulb was known and much esteemed in Egypt 2000 years before Christ. It still forms a favourite addition to the food of the Egyptians. Hasselquist, in a panegyric on the exquisite flavour of the Egyptian onion, remarks, that it is no wonder the Israelites, after they had quitted their place of bondage, should have regretted the loss of this delicacy; for whoever has tasted of the onions of Egypt, must acknowledge that none can be better in any part of the universe. "There," says he, "they are mild and pleasant to the palate; in other countries they are strong and nauseous. There they are soft and yielding; but in countries to the north they are hard, and their coats so compact, as to render them less easy of digestion." The Egyptians divide them into four parts, and eat them roasted together with pieces of meat; which preparation they consider so delicious, that they devoutly wish it may form one of the viands of Paradise. A soup made of these onions was pronounced by the learned traveller to be certainly one of the best dishes of which he ever partook.

This predilection for the savoury bulb extends in Africa beyond the country of the Nile. Major Denham, in his route south from Bornou, observed numerous gardens; but the only vegetable produced in them appeared to be onions.

The following varieties of the onion are those commonly cultivated in our gardens:

Dutch blood red.
Deptford.
Early silver skinned.
Globe.
James long keeping.
Lisbon.
Pale red.
Potatoe onion.
Silver skinned.
Spanish.
Strasburgh.
Tripoli.
True Portugal.
Two-bladed.
Welsh.
Yellow.

A rich mellow ground, on a dry subsoil, is the most favourable to the growth of this plant. It is propagated by seed sown broad-cast in spring; the quantity of seed being regulated according to the destination of the onions, whether they are to be drawn young, or to remain for bulbing. The plants begin to bulb in June, increasing in growth till the middle of August, when the necks shrink and the leaves decay; they are then in a fit state to be drawn, and preserved for the winter store.

A method of improving the size of onions, by transplanting them, was recommended by Worlidge, so early as the beginning of the seventeenth century, in his "Systema Horticulturæ;" and this practice has lately been revived with great success by some eminent horticulturists.

The theory on which it is founded is extremely ingenious. Every plant which lives longer than one year, generates the sap or vegetable blood which will elaborate the leaves and roots of the succeeding spring. In bulbous roots this reserved sap is deposited in the bulb, which, in a great measure, it composes. Now the store which is thus formed varies considerably in the same species of plant, according to the particular circumstances under which it is raised. Thus the onion in the south of Europe accumulates a much greater quantity in a single season, under a greater degree and longer duration of heat, than is afforded by our colder climates, and therefore it acquires, in a given time, a much larger size. Mr Knight was induced by these observations to suppose that two short and variable summers in England might, perhaps, be equal in effect to one long and bright season in Portugal; and, accordingly, he attempted a method of culture which has proved his inference to be correct. In pursuance of this plan, seeds of the Portugal onion were sown in spring very thickly, on a poor soil, and in a shady situation. Under these circumstances, the bulb in the autumn had attained scarcely beyond the size of a large pea. The bulbs were then taken from the ground and preserved during the winter; in the ensuing spring they were again planted at equal distances. From this treatment the plants afforded bulbs very superior to those raised immediately from seed, some exceeding five inches in diameter; and being more matured, they may be preserved sound throughout the winter with greater certainty than those which are raised from seed in a single season. Many other cultivators pursue, with some slight alterations, the same method, and find it perfectly successful.

It is found that in those countries in which the onion comes to the greatest perfection, the practice of transplanting it prevails.

In Portugal it is sown in November and December on a moderate hot-bed, and protected from the frost; in which situation the plants re-

main till April or May, when they are transplanted to a rich soil.

Onions are considered wholesome under any form; but they become more succulent and mild after having undergone culinary preparation.

The Welsh Onion, or *Ciboule (allium fistulosum)*, is originally from Siberia. It is a hardy plant, and strong in flavour, approaching more nearly to garlic than onion. This species does not form a bulb. The cultivation of the ciboule has been known in England since the early part of the seventeenth century; how much earlier there are now no means of knowing. It is much less cultivated in the present day than it was in former times, when broths and pottages, seasoned with the green tops of the onion tube, were more in fashion. It is now only occasionally raised for a spring crop. For this purpose the seed is sown at the end of July or August; in a fortnight the plants usually appear above ground; but in October their leaves wither, and the ground appears quite bare. In the beginning of the ensuing year, however, they become renovated, and in March are fit for drawing to be used as onions. The *scalien* is another name given to long-necked onions, which produce leaves abundantly, but do not bulb.

The Tree, or *bulb-bearing Onion (allium cepa*, var. *viviparum)*, is a singular variety, which has probably been produced by climate. It runs with a strong stem, about two feet in height, on the top of which the flowers are produced in a manner similar to the rest of the species; but instead of being succeeded by capsules containing seeds, the germs swell, and towards the end of the season a crop of bulbs is obtained from the top of the stalk, and which, in a natural state, as soon as they drop off and fall to the ground, begin to put out roots and vegetate. This variety is more an object of curiosity than of use, though we learn that in some parts of Wales these bulbs are planted, and produce ground-onions of a considerable size, while the stem supplies a succession of bulbs for the next year's planting.

This variety is said to have been introduced here from Canada; the French call it *l'ognon d'Egypte;* there is no proof, however, of its being a native of the country which its name would indicate, while the probability is greatly to the contrary. It is not in such a climate, but in cold and wet countries, that seminal plants are changed to viviparous. The same species of grass which has perfect seeds upon warm and dry grounds, bears little plants in the spike when grown upon the cold and humid mountain top; and the corn, which in a dry season remains firm and without any signs of vegetation in the grain, sprouts in the ear, and becomes green and matted in the shock, when the weather is rainy; this effect being produced much more frequently in the northern parts of the country than in the south. It is by no means improbable that, in the humid atmosphere of the Hebrides, both grain and pulse would become viviparous, if they were not taken to the barn and dried by artificial means. By analogy drawn from facts it is therefore probable that the tree-onion is not only from Canada, but that it is not indigenous there, being merely the common onion introduced from France by the colonists, and changed to the viviparous form by the climate.

The Ground, or *Potatoe Onion*, is another curious variety. This multiplies itself in an opposite direction to that of the tree-onion, producing, by the formation of young bulbs on the parent root, an ample crop below the surface. This plant has also been described as being a native of Egypt, or at least as having been brought from that country by the British army in the early part of the present century. It must be admitted that a plant which bears an additional number of bulbs is more likely to be a native of a dry and warm climate than a plant which is viviparous. The time of the introduction of the potatoe-onion has, however, been erroneously assigned, since it was known and cultivated in the south and west of England some years prior to the Egyptian expedition. If it be a native of Egypt, or of any other warm country, it is, indeed, a hardy one, since it bears the alteration of the seasons, and resists the attacks of insects much better, it is said, than the common onion.

The bulbs are planted in the middle of winter; as the tops appear they are usually earthed up like potatoes, and by the middle of summer the new crop is ready for removing. The size and number of the new bulbs depend very much on the size of those which have been planted; but they always yield a proportionately large produce.

Mr Wedgewood employs another method. He says, when the onions have shot out their leaves to their full size, and when they begin to get a little brown at the top, he clears away all the soil from the bulb down to the ring from whence proceed the fibres of the roots, and thus forms a basin round each bulb, which catches the rain, and serves as a receptacle for the water from the watering pots. The old bulbs then immediately begin to form new ones; and if they are kept properly moist, and the ground good, the clusters will be very large and numerous; besides, bulbs grown thus above ground are much sounder than those grown below, and will keep much better.

The Chive *(allium Schœnoprasum)*, is the smallest, though one of the finest flavoured of the genus. It is a hardy perennial plant, an inhabitant of Siberia, and said to be a native of Britain, though rarely found growing in an uncultivated state. The bulbs are very small, connected in clusters of an elongated form, and the

leaves are long, slender, and pointed. The flowering stem, when it is allowed to rise, is slightly curved, and seldom attains to more than a few inches in height. The flowers are white, with a purple tinge; they grow crowded together, and are, even in the most cold and moist situations, followed by capsules and seeds. When cultivated, the plants are, however, seldom allowed to run to seed, as they are not usually drawn to be eaten entire, but have the leaves and young tops cut off to be used as a potherb. Chives are very hardy, and require no attention during their growth except to keep them free from weeds; they are propagated by slips, or by dividing the roots in the spring or autumn.

When the leaves are gathered for use, if they are cut close, others will shoot up in succession, and in this manner a bed lasts three or four years; after which period it must be renewed. When fresh cut, these leaves are by some persons considered as an improvement to salads and seasonings. Their flavour suffers greatly if they be kept after gathering even for a very short time, and their produce is but small in proportion to the labour of gathering. On these accounts they are not much cultivated in places where vegetables are supplied in the markets; and they seldom find a place in the garden of the English peasant, who, partly from ignorance, and partly from prejudice, does not live much upon those soups and savoury dishes which, while they are more wholesome and nourishing than the food which he consumes, are also considerably cheaper.

The Leek *(allium porrum)*, is said to be indigenous to Switzerland, whence it was introduced into this country; but it has been for so many ages under cultivation, that its native place cannot, perhaps, be very accurately traced. According to translators and commentators, this, as well as the onion and garlic, was included among the Egyptian luxuries after which the Israelites pined. It still makes its constant appearance at the tables of the Egyptians, who eat it chopped small as a savoury accompaniment to meat.

The exact period when the leek was first brought into this country is not known; but it is mentioned by Tusser, in his "Five Hundred Points of Good Husbandry," as early as 1562. There is, however, every reason for believing that it was introduced prior to that time, and had long been the favourite badge of the Welsh principality. Shakspeare makes this to have arisen at the time of the battle of Cressy.

Worlidge gives a good idea of the love of the Welsh for these kinds of odoriferous vegetables. He says, "I have seen the greater part of a garden there stored with leeks, and part of the remainder with onions and garlic."

The hardiness and pungency of the leek both tend to recommend it in those countries where few potherbs are grown, and it seems to have great facility in adapting itself to climate. The leek which is cultivated in the colder parts of Scotland, and thence is called the Scotch leek, is more hardy and also more pungent than the broad-leaved variety, chiefly cultivated in England. It was formerly a very favourite ingredient in the "cock-a-leekie" of the Scotch, which is so graphically described in "The Fortunes of Nigel;" and of which James the First is reported to have been so fond, that he retained his preference for it notwithstanding all the dainties of London cookery.

This species requires more boiling than others of the same genus, and unless it be reduced nearly to a pulp, it taints the breath in a very offensive manner. The offensive odour of a vegetable is, however, no evidence of unwholesomeness, provided the odour is natural to it, and not the result of putrefaction.

The bulb of the leek consists of the bottoms of the leaves, which do not form in bulbules or cloves like those of the garlic, neither are they so entire as the tunics of the onion; the stem runs to the height of about three feet; the flowers, which are bell-shaped, appear in May, in large close balls, followed by capsules containing seeds. As the root of the leek is rather the blanched end of the leaves than a bulb, properly so called, the plant is to be considered chiefly as a potherb; though in some places both the root and the greater part of the leaves are eaten by the peasantry as an accompaniment to their bread. Its chief value, however, is as a potherb, which stands the winter well, and is in a forward and succulent state at that part of the season when fresh vegetables are the least abundant. The culture of the leek is similar to that of the onion.

The Shallot *(allium Ascalonium)*, is a native of warmer climates than that of England. It is found growing wild in many parts of Syria, especially near Ascalon, whence it derives its name. The time of its introduction into this country is not known. Some writers assume that it was brought home by the crusaders. It is mentioned as a well known plant by Turner, in his "Signes of Herbes," published in 1548. This plant resembles the true garlic in having its roots divided into cloves or smaller roots, and enclosed in a thin membrane. Each of these small roots sends forth two or three fistular awl-shaped leaves, issuing from a sheath; they are nearly similar, but not so large, as those of the onion. The shallot does not in all situations produce perfect seeds, or even flowers, and sometimes, indeed, does not send up any foot-stalk. The want of seed is, however, fully compensated by the multiplication of the roots. It is sufficiently hardy to bear uninjured the severest winters of England; but it is liable sometimes to be attacked by insects. This evil is found to be surely prevented when the bulbs are planted

rather above the surface, instead of being buried in the earth; and this improved mode of culture has a farther advantage of bettering the quality and increasing the quantity of the crop obtained.

The flavour of the shallot is much more pungent than that of garlic, but not nearly so rank. It seasons soups and made-dishes, and makes a good addition in sauces, salads, and pickles.

Rocambole *(allium scorodoprasum)*, is a native of the northern parts of Europe, and is found in situations which are rather elevated. It has been cultivated in this country, though not very extensively, from a period much anterior to any annals of horticulture. The earliest records on this subject mention it as being a plant in common cultivation. It is a perennial, having narrow flat leaves, with the mark of a keel or ridge on the under sides. The flower-stem rises to the height of about two feet; the globular head, on its first appearance, is contorted. As the plant advances, however, the head untwists, and the flowers come to maturity; after which the spherical top changes into a cluster of small bulbules, which have a tinge of purple. The cloves of the rocambole, taken either from the root or the top of the flowering stalk, are the parts used; the latter being the largest in size; but those from the roots have the most pungency, especially when the whole of the bulb is buried in the earth.

Rocambole holds an intermediate place between garlic and shallot, and is applied to the same purpose as the latter.

Orchis, class *gynandria*, order *monandria*, of Linnæus. The orchidiæ form a numerous and curious family of plants. They are rather difficult of culture. Few of the species produce seeds, and they are propagated by their bulbs or tubers, which are of a peculiar structure. An orchis, when taken out of the ground, is found with two solid masses, of an oval form, at the base of the stem, above which spring out the thick fleshy fibres which nourish the plant. One of these bulbs or tubers is destined to be the successor of the other, and is plump and vigorous, whilst the other, or decaying one, is always wrinkled and withered. From this withered one has proceeded the existing stem, and the plump one is an offset, from the centre of which the stem of the succeeding year is destined to proceed. By this means the actual situation of the plant is changed about half an inch every year; and as the effect is always produced from the side opposite to the withered bulb, the plant travels always in one direction, at that rate, and will in a dozen years have marched six inches from the place where it formerly stood. In the garden the orchis can hardly be said to be propagated. The species are generally taken up from their native habitations with balls, and transferred to a shady border, where they remain for a year or two, but seldom increase. Those which grow in the open fields are generally found in a calcareous soil, and those in bogs or woods thrive best in peat, or peat and loam mixed.

Several species of the orchis afford the substance called salep. This word is supposed to have been derived from the Arabic name of the plants, which is *sahhleb*.

Orchis Mascula, is the species usually employed for the manufacture of salep. It grows

110.

Orchis.

abundantly in Oxfordshire, and there salep of the best quality has been manufactured from the roots. The great proportion of that used, however, comes from the Levant. The plant consists of a root, composed of two lobes, from which proceed broad oblong spotted leaves. The flower-stalks are about twelve inches long, are furnished with one or two narrow leaves, and terminated by a long spike of reddish purple flowers, which have a slight but very agreeable odour. The flowers make their appearance in the months of June and July. It prefers a dry, rather light soil. In rich loamy soils, which have been fully manured, this plant does not thrive; the roots become black and half rotten. The root is ascertained to be fully matured when the leaves and stalk begin to decay. The plants may then be dug up, and the new formed bulbs, from which alone the salep is prepared, separated from the dry shrivelled one.

The most approved mode of treating the roots is as follows: The root is to be washed in water, and the fine brown skin which covers it is to be separated by means of a small brush, or by dipping the root in hot water, and rubbing it with a coarse linen cloth. When a sufficient number of roots have been thus cleansed, they are to be spread on a tin plate and placed in an oven, heated to the usual degree, where they are to re-

main six or ten minutes, in which time they will have lost their milky whiteness, and acquired a transparency like horn, without any diminution of bulk. Being arrived at this state, they are to be removed, in order to dry and harden in the air, which will require several days to effect; or by using a very gentle heat, they may be finished in a few hours. The Turkey salep comes to this country in oval masses, hard, and semi-transparent, of a yellowish white colour.

Salep has been lauded as containing a greater quantity of nourishment, in a given bulk, than any other vegetable body; we suspect, however, that in this respect it must yield to good wheaten bread. It has been said, however, that an ounce of powdered salep, mixed with an ounce of animal jelly or portable soup, and boiled in two quarts of water, will be sufficient for the daily food of an able-bodied man. It has accordingly been recommended as a part of ships' stores on a long voyage. A small quantity of salep added to milk retards the latter from becoming sour. The late Dr Percival of Manchester proposes this substance as a mixture in wheaten bread. I directed, says he, an ounce of the powder to be dissolved in a quart of water, and the mucilage to be mixed with a sufficient quantity of flour, salt, and yeast. The flour amounted to two pounds, the yeast to two ounces, and the salt to eighty grains. The loaf when baked was remarkably well fermented, and weighed three pounds twelve ounces. Half a pound of flour and an ounce of salep were mixed together, and the water added according to the usual method of preparing bread. The loaf when baked weighed thirteen ounces and a half; but it should be remarked that the quantity of flour used in this trial was not sufficient to conceal the peculiar taste of the salep.

Salep was at one time in considerable esteem as a medicine. It is now never used by medical men but as an article of diet for invalids, when a light nutritious vegetable food is advisable.

The Egyptian Water Lily *(nymphea lotus)*. This plant grows in vast quantities in the plains of Lower Egypt, near Cairo, during the time the land is under water. It flowers about the middle of September, and ripens towards the latter end of October. The Arabians call it *nuphar*. The sacred lotus of Egypt has given rise to much controversy among the learned. In fact it appears that several plants were called by this name by the inhabitants of different parts of the country. According to Shaw, in the plate that represents the mosaic pavement at Præneste, relating to some of the plants and animals of Egypt and Ethiopia, the lotus of these countries is unquestionably a water lily, of which three kinds are mentioned by Des Fontaines, and represented on many Egyptian monuments. Two of them, he says, have been well described in the works of Herodotus and Theophrastus; one has white flowers and fruit like that of a poppy, full of a great number of small seeds; this is the *nymphea lotus* of Linnæus. The other, called by Herodotus the lily rose of the Nile, and by Theophrastus the Egyptian bean, or lotus of Antinoüs, has a flower of a lovely red, and a fruit shaped like the rose of a watering-pot, pitted with deep hollows, each containing an oblong seed as large as a small filbert; this is the *nymphea nelumbo* of Linnæus, the *cyannus nelumbo* of Sir J. E. Smith, and according to him, the *kuamos* of the ancients, which has been confounded by other able writers with the true lotus of Egypt, and has probably become important in the Egyptian mythology only as a substitute for the former. This fruit, compared by Theophrastus to a wasp's nest, is represented in various Egyptian monuments. See the *nymphea lotus*, plate VII., fig. 7. The red-flowered lotus is common in India, but has disappeared in Egypt. The third species has blue flowers, and a fruit like the first; it is likewise delineated on the monuments of antiquity, and has been noticed by Athenæus. This author says, that at Alexandria the crowns worn at the festivals of Antinoüs were composed of the red or the blue lotus. Delile observed the blue water lily lotus in Egypt, and has described it under the name of *nymphea cerulea*.

Several other plants deserving notice belong to this division of the vegetable kingdom; but as they come under the heads of medicinal or ornamental plants, we shall recur to them under those heads. Of such are the aloes, the various kinds of lilies, &c. The pine apple we shall also describe among the other fruits.

CHAP. XXX.

DIVISION III. DICOTYLEDONOUS PLANTS.—THE POTATO, &c.

We now come to the third great division of the vegetable kingdom, where the seeds of all the plants are found to be divided into two lobes or cotyledons; a familiar example of which we have in the common bean, or in the seed of the oak or elm. There is but one exception to this general character, and that is in the family of the pines, or coniferæ, whose seeds consist of from three to ten different parts, or verticellate cotyledons.

Dicotyledonous plants, as we have already explained, are characterised from the members of the two other divisions, by the internal organization of their stem, (Chap. VI.) of which all the parts are disposed in concentric layers; the disposition and mode of branching of the nerves of the leaves; the circumstance of five or

one of its multiples being the prevalent number in almost every part of the flower, the very frequent prevalence of both a calyx and corolla; and lastly, the general aspect of the plants.

Dicotyledonous plants have been distinguished into four divisions, according to the structure of the corolla, as the *Apetalous*, *Monopetalous*, *Polypetalous*, and *Diclinous*.

There have been enumerated in the natural system as belonging to this division one hundred and twenty-five families, including a great proportion of those trees, shrubs, and herbs, which are conducive to the necessities or luxuries of mankind. A systematic list of these natural families we shall give afterwards; in the mean time, we proceed to describe those vegetables in this division which are appropriated as food to man.

The Potato, (*solanum tuberosum.*) This valuable plant belongs to the family *Solaneæ* of Jussieu; almost all the species of which family are of a poisonous and narcotic quality, as the *belladonna*, *solanum dulcamara*, *hyosciamus*, *tobacco*. What is remarkable, however, it is only particular parts of many of these vegetables which possess the narcotic qualities, the other parts being perfectly innoxious and edible. Thus the root and berry of the dulcamara are perfectly harmless, as well as the root of the solanum tuberosum. The solaneæ are characterised by the peculiar form of the flower, of which that of the potato is a familiar example. The potato

111

The Potato.

belongs to the Linnæan class *Pentandria*; order *Monogynia*. It is a perennial herbaceous plant, rising with a slender branching stem to the height of two or three feet. The leaves are of a roundish form, of unequal size, and of a dark green; the petals are white, or of a purplish tinge; the fruit is a large berry with a greenish pulp, which latterly changes to black, containing numerous small seeds in the centre.

Besides the true roots of the plant, there are numerous runners which grow out from the stem, and which bear the tubers or potatoes. There are numerous scars or eyes on the tuber, from whence proceed the rootlets and future germs of a new plant; hence, in cutting up potatoes for seed, care must be taken that each division possesses one of these eyes or points of germination. The pointed end of the potato which is attached to the runner or root, is more matured than the rounder end, which is of a soft, waxy, and watery nature, while the other is dry and farinaceous.

Gomara, in his General History of the Indies, and Josephus Acosta, are amongst the early Spanish writers who have mentioned the potato by the Indian names, *openanck*, *pape*, and *papas*. Clusius, and after him Gerard, gave figures of the plant; and Gerard gave it the name of *solanum tuberosum*, which Linnæus adopted.

There is perhaps no vegetable product, not even excepting the cerealia, or the most useful of the palm tribe, which has proved of such essential importance, or which is likely still to have such an influence on the population of the temperate regions as this admirable root. One could scarcely have believed that, in little more than two centuries, a small and almost neglected tuber, transported from the newly discovered regions of Mexico, where it occupied but a very insignificant space, and was but sparingly, if at all used as human food, should have been multiplied so as to form the principal subsistence of millions of human beings for succeeding generations. Humboldt, in his essay on the kingdom of New Spain, gives the history of the potato. He believes that the plant described by Molina under the name of Maglia, is the original stock of this useful vegetable, and that it grows in Chili in its native soil. He supposes that thence it was transported by the Indian population to Peru, Quito, New Granada, and the whole Cordilleras.

Among the Chonos islands, Mr Darwin saw the wild potato growing abundantly. They grow near the sea beach in thick beds, on a sandy shelly soil, wherever the trees are not too close together. In the middle of January they were in flower; but the tubers were small and few in number, especially in those plants which grow in the shade, and had the most luxuriant foliage, "Nevertheless, I found one," says he, "which was of an oval form, with a diameter two inches in length. The raw bulbs had precisely the smell of the common potato of England; but when cooked they shrunk, and became watery and insipid. They had not a bitter taste, as, according to Molina, is the case with the Chilian kind, and they could be eaten with safety. Some plants measured from the ground to the tip of the upper leaf, not less than four feet. There can be no doubt, from the state in which they grow, and from their being known to the various Indian tribes scattered over the country, that they are indigenous, and not imported plants." * Mr Cruickshanks thus farther corroborates the above remarks.

* Darwin's Natural History of voyage to South Seas, 1840.

Mr Lambert, in the tenth volume of Brande's Journal, and in the appendix to his splendid work on the genus *Pinus*, has collected many valuable facts which prove that the potato is found wild in several parts of America, and among others in Chili and Peru. Don José Pavon, in a letter to Mr Lambert, says, "The *Solanum tuberosum* grows wild in the environs of Lima, and fourteen leagues from Lima on the coast; and I myself have found it in the kingdom of Chili;" and Mr Lambert adds, "I have lately received from Mr Pavon very fine wild specimens of *solanum tuberosum*, collected by himself in Peru." There is also a note from Mr Lambert on the same subject, in the third volume of the New Edinburgh Philosophical Journal, with an extract from a letter of Mr Caldcleugh, who sent tubers of the wild plant some years ago, from Chili to the Horticultural Society. But it is frequently objected, that in some of those countries where the potato is found wild, it may, like many other species met with in that state in America, be an introduced, not an indigenous plant. There are, however, many reasons for believing that it is really indigenous in Chili, and that wild specimens found there have not been accidentally propagated from any cultivated variety. In that country it is generally found in steep, rocky places, where it could never have been cultivated, and where its accidental introduction is almost impossible. It is very common about Valparaiso, and I have noticed it along the coast for fifteen leagues to the northward of that port; how much farther it may extend north or south, I know not. It chiefly inhabits the cliffs and hills near the sea, and I do not recollect to have seen it at more than two or three leagues from the coast. But there is one peculiarity in the wild plant that I have never seen noticed in print, that its flowers are always pure white, free from the purple tint so common in the cultivated varieties, and this, I think, is a strong evidence of its native origin. Another proof may be drawn from the fact, that while it is often met with in mountainous places, remote from cultivated ground, it is not seen in the immediate neighbourhood of the fields and gardens where it is planted, unless a stream of water run through the ground, which may carry tubers to uncultivated spots. Having observed the distribution of this and other plants through the agency of the streams employed for irrigating the land, I am led to think, that the wild specimens found near Lima may have had similar origin. If they occurred in the valley, this is more than probable, as almost the whole of the land is either cultivated by irrigation, or the uncultivated spots are overflowed when the river is swelled by the rains in the interior. Upon the whole, it may be safely concluded that this important vegetable is really indigenous to Chili; but with respect to Peru, some further evidence appears necessary to remove all doubt on the subject. The question can only be decided by ascertaining the exact situations in which the plants present themselves at Lima and Chancay, especially with respect to land that is or has been cultivated. It would be interesting, too, to know the colour of the flowers.

There is strong evidence for believing that this plant was first introduced into England by the colonists adventuring to North America under the auspices of Sir Walter Raleigh, who had obtained a patent in 1584, from Queen Elizabeth, "for discovering and planting new countries not possessed by Christians." Thomas Heriot, afterwards known as a mathematician, was among these voluntary exiles; who, however, all returned within two years after they had first gone forth for the purpose of founding a colony. These voyagers most probably brought home the potato, since in Heriot's report of the country, which is printed in De Bry's collection of Voyages, he describes (vol. i. p. 17,) under the article Root, a plant called openawk, which, there is little doubt, is identical with the potato. "The roots of this plant," says he, "are round, some as large as a walnut, others much larger; they grow in damp soils, many hanging together as if fixed on ropes. They are good food either boiled or roasted." The introduction of this plant into Ireland by Sir Walter Raleigh, on his return from Virginia, is indeed well authenticated by corroborative testimony. In the manuscript minutes of the Royal Society, we find that Sir R. Southwell distinctly stated to the fellows, that his grandfather was the first who cultivated the potato in Ireland, and that for this valuable root he was indebted to Sir Walter Raleigh.* Among the anecdotes told of this enterprising voyager, it is said that when his gardener at Youghall, in the county of Cork, had reared to the full maturity of "apples" the potatoes which he had received from the knight, as a fine fruit from America, the man brought to his master one of the apples, and asked if that were the fine fruit. Sir Walter having examined it, was, or feigned to be, so dissatisfied, that he ordered the "weed" to be rooted out. The gardener obeyed, and in rooting out the weeds found a bushel of potatoes.

In contradiction to the above account, Dr Campbell, in his Political Survey, states that this plant was not introduced into Ireland until the year 1610; while some writers affirm that the people of that country were in possession of the potato at a period prior to the one just assigned. One supposition is, that this root was brought from Santa Fe into Ireland in the year 1565; and another, that it is of so very ancient

* Library of Useful Knowledge.

a date in that island as to make it equally probable that it is a native vegetable of the country.

It is found, however, that the plant carried to Ireland by Captain Hawkins, in 1565, was the Spanish batata, or sweet potatoe. The claim to its greater antiquity in that country was made by Sir Lucius O'Brien, who stated to Mr Arthur Young that the venerable Bede mentioned this plant as being in Ireland about the year 700. Sir Lucius did not, however, point out the passage containing any proof of his assertion; and the potato, largely as it is cultivated in that country, has not yet made out its title to a place in the indigenous flora of Ireland.

Gerarde mentions in his Herbal, published 1597, that he cultivated this plant in his garden, where it succeeded as well as in its native country. He gives a drawing, which he distinguishes by the name of Virginian potato, having, as he states, received the roots from Virginia, otherwise called Nozembega. It was, however, considered by him as a rarity, for he recommends that the root should be eaten as a delicate dish, and not as common food.

From the authority of more than one writer, it would appear that the potato was brought into southern Europe through a different channel, and at an earlier period than the introduction of the root from Virginia into this country. Clusius relates that he obtained this root at Vienna in 1598, from the governor of Mons in Hainault, who had procured it in the preceding year from Italy, where, in common with the truffle, it had received the name of *taratouffli*. Peter Cieca, in his Chronicle, printed in 1553, chap. xl. p. 49, relates that the inhabitants of Quito and its vicinity, besides producing maize, cultivated a tuberous root which was used as food under the name of *papas:* this, it is affirmed, is the same plant which had been transplanted to the south of Europe, and which Clusius received from Hainault.

Though now so extensively used, the value of this root as an esculent, was not perfectly appreciated for a great length of time in this country, during which period it was indeed only cultivated in gardens, and that as a curious exotic. The potato was considered as a great delicacy in the reign of James the First. At that period, though it formed one of the articles provided for the household of the queen, the quantity used was extremely small, and exorbitantly dear, being at the price of two shillings per pound. This esculent remained equally scarce throughout the turbulent times of the succeeding reign, and during the Commonwealth. Its cultivation very gradually spread in different parts of Ireland, and also into Lancashire, but not till nearly a hundred years after the discovery of Virginia by Raleigh. Mr Buckland of Somersetshire, in the year 1663, drew the attention of the Royal Society to its value, earnestly recommending the general cultivation of the potato throughout the kingdom to guard against a famine. This appeal was not made in vain. A committee was appointed to inquire into its merits, and all those Fellows of the society who had lands adapted for the growth of the potato, were entreated to plant them with that vegetable; while Mr Evelyn was requested to notice the subject at the close of his Sylva. This celebrated man appears, however, not to have been aware of the importance of the potato as an article of food, for he did not mention it until more than thirty years after that period, and then in rather slighting terms. In his Kalendarium Plantarum, the first gardener's calendar published in Britain, he thus writes: Plant potatoes in your worst ground. Take them up in November for winter spending, there will enough remain for a stock, though ever so exactly gathered. In another of his works, Acetarius, he remarks that the small green fruit or apples of the potatoe make an excellent salad. This assertion has not, however, been verified by experience.

The zeal of the Royal Society to promote the growth of this vegetable, failed for a long time to exercise much influence upon the habits of the nation; and, if we may judge from the opinions which were published respecting the plant, we must conclude that the necessities of the poor of Ireland, who have ever been left too entirely to their own resources, did more to promote the culture of potatoes than all the labours of the learned, and the philanthropy of the patriotic. At the end of the seventeenth century one writer on gardening, indeed, admits that "potatoes are much used in Ireland and America as bread, and may be propagated with advantage to poor people." Woolridge, who wrote in 1687, twenty-four years after the appeal of Mr Buckland, describes potatoes as being very useful in "forcing fruits," stating that they are planted in several places in this country to good advantage; he adds, "I do not hear that it has been yet essayed whether they may not be propagated in great quantities for the use of swine and other cattle." The celebrated Ray, who began to publish his Historia Plantarum in 1686, takes no farther notice of this vegetable than by saying that it is dressed in the same manner as Spanish batatas. Merritt, who wrote in the following year, records that potatoes were then cultivated in many fields in Wales, but in what part of the principality he does not mention.

On the other hand, Lisle, who made observations on husbandry from the year 1694 to 1722, is wholly silent about the potato. In Mortimer's Gardener's Kalendar for 1708, this plant is directed to be sown in February; and, as if its character had not been generally known,

it is added, that "the root is very near the nature of the Jerusalem artichoke, although not so good and wholesome, but that it may prove good for swine." In the Complete Gardener, by the eminent nurserymen, Loudon and Wise, the seventh edition of which was published in 1719, no mention is made of this root; and Bradley, who wrote about the same time, and whose very extensive works on horticultural subjects treated expressly on new improvements in the art, notices it as if by compulsion. "They (potatoes) are," says he, "of less note than horse-radish, radish, scorzonera, beets, and skirret; but as they are not without their admirers, I will not pass them by in silence."

These facts and extracts are curious, as they serve to show that this most valuable article of food was not brought into general use by the skill and labour of professional men, but in defiance of their prejudices, and the bad methods of culture which they promulgated. There can indeed be little doubt that the imperfect modes of both cultivating and preparing the potatoe as an esculent, were in a great measure the causes which prevented its more speedy adoption as a wholesome and substantial article of food; while this very ignorance of its nature and management produced the low estimation in which it was held by writers about the beginning of the eighteenth century.

To those who know anything practically of the cultivation of this plant, it must be evident how much the early sowing, the late taking up, and the leaving in the ground during winter of the roots intended for propagation, tended to deteriorate the quality of the potatoes. These circumstances, together with the little culinary skill exercised in its preparation, caused it to appear under no very tempting form. A person who had been invited to taste the first potatoes which were planted in the county of Forfar, in or about the year 1730, related that the roots had been merely heated, and that they adhered to the teeth like glue, while their flavour was far from agreeable. The food was about to be condemned through the ignorance of the cook, when the accidental arrival of a gentleman who had tasted a potato in Lancashire, caused the rejected roots to be remanded back to the hot turf ashes, till they became as dainty as they had before been nauseous.

We have no records of the early practice and progress of potato husbandry in Ireland. The more tardy progress, and the less favourable results, attendant on this culture in England, might induce a belief that it had been better conducted in the former country; though no doubt the more genial climate of Ireland, its humidity, and the absence of those chilling winds from the east, which are so often fatal to the tender spring crops of England, gave to it a natural advantage, and might perhaps sufficiently account for the superiority of this branch of husbandry in Ireland over England.

The early practice in this country of planting potatoes in February was, in itself, an effectual bar to their goodness as field culture, since the young plants betray their origin to have been from a warmer climate, by their inability to bear the slightest degree of frost with impunity; so that if they put forth their tender heads to the nipping frosts of spring, a great part of the crop is certain to fall a sacrifice. The better quality of the potato grown in Ireland, and its excellence as a substantial article of food among a population sunk to the lowest state of poverty, caused it to be brought into general use in that country, finding its way even to the tables of the rich, at a period when it was scarcely known in the sister island.

The introduction of this plant into Scotland was probably earlier than into any part of England, with the exception, perhaps, of Lancashire. The people living in that county were then distinguished by a marked difference of habits, manners, and character from their neighbours. A remnant of these peculiarities is even still to be found, notwithstanding the singularities of the inhabitants, and local circumstances, combined to render this a favourable situation for the introduction and improvement of the potato.

The land in Lancashire is rather poor, and the climate rainy, so that wheat, with even the present improved system of husbandry, cannot be raised to very great advantage. Oats were consequently, there, as in Ireland and the lowlands of Scotland, the staple production. The mechanics, who worked chiefly in iron and brass, were all cottagers, who followed their respective employments in the winter, and raised food for themselves upon their little patches of land in the summer. The population of Lancashire then bore a great resemblance to the cotters of Ireland. They were, however, more ingenious in handicraft works, and still more resembled the manufacturing peasantry in the centre and south of Scotland, who grow the whole or the greater part of their food upon their cottage lands. Even the education of their children was formerly often obtained out of the produce of their little field; the school-master went thigging, that is, collecting a portion of produce from every cottager, in proportion to the wealth of the individual, and to the number of pupils he might have contributed to the school-room. The poor likewise were relieved by a voluntary contribution of produce, and it is probable that this system worked as well as that of a compulsory rate. Even in the smaller burghs of Scotland, and in the villages where the lands are held on *feu* or perpetual lease, the same system was, and in many places still is, followed. The portion-

ers, as they are called, are allowed a house in the village, and land for their subsistence, in the surrounding fields.

In such a state of the peasantry the cultivation of the potato would offer peculiar advantages, as no other substantial article of food could be raised by the inexperienced rustic in equal quantities, with so little risk and trouble, and without any but his own and his family's being required for its culture and after-preparation. Accordingly, when once this plant was introduced into cottage cultivation in Scotland, its importance was quickly recognized.

It is understood, however, that this valuable root was not, until the year 1728, made the object of useful culture among the Scotch, and they were then indebted to a cottager for first attempting its culture. This man's name was Thomas Prentice; he was a day-labourer living near Kilsyth, in Stirlingshire, and drawing his subsistence partly from the produce of his little plot of ground. This crop proved extremely valuable, and was almost instantly in demand for propagating other crops, first among the cottagers, and then among the farmers. Prentice continued to cultivate this root very carefully, and to supply his neighbours with the produce of his crop. He was, moreover, frugal and industrious, so that in a few years he found himself in possession of two hundred pounds, no small fortune at that time and in that place. When he had "made his fortune," he sank his capital in an annuity, at a good interest, upon which he lived independently to an old age. The last years of his life were spent in Edinburgh, where he died in the year 1792, at the advanced age of eighty-six, having thus been, for sixty-four years, a witness to the happy effects of the blessing which he had been instrumental in conferring on his country.

But notwithstanding the success that attended the culture of the potato among the cottagers, its progress among the higher classes in Scotland was retarded by the opinions of the writers formerly alluded to; while, what is not a little singular, a mistaken zeal in religious matters made some of the Scotch folks hostile to the innovation. "Potatoes," said they, "are not mentioned in the bible," and thus the same anathema was pronounced against them as against the "spinning-wheel," and the "corn farmers."

The name of this plant was indeed inserted in the Hortus Medicus Edinburgensis, published by Sutherland in 1683. It is therefore probable that the potato had been introduced as a curiosity into some of the gardens about Edinburgh some time before it was brought into full culture by Prentice. But if its management was the same as that recommended by so great an authority as Evelyn, the produce was, most probably, of little value.

The year 1742, which was long remembered in Scotland as the "dear year," gave an impulse to the cultivation of the potato. Old people who were still living at the beginning of the present century, represented the state of things in the summer of 1743 as being dreadful. Many of the destitute wandered in the fields seeking to prolong the misery of existence by devouring the leaves of pease and beans, of sorrel and other wild plants, while not a few perished from absolute want, and still more were carried off by those diseases which always follow and aggravate the devastations of famine. This state of distress naturally called the general attention to the cultivation of the potato, and indeed to the whole agriculture of the country. So that, during the latter half of the eighteenth century, the practice and science of husbandry made much more rapid progress in Scotland than in England. Previously to this general scarcity in 1743, some potatoes which were growing in the county of Roxburgh, were so uncommon as to have been considered objects of curiosity. But the state of things soon altered; and immediately after the "dear year," the farmers of Lothian began to make this a branch of field husbandry.

In England, with the exception of Lancashire, the progress of the cultivation of the potato continued at an extremely slow pace. It was known in Yorkshire only as garden produce down to 1760; and in Somersetshire it was rare indeed to meet with a whole acre under this culture so late as 1770.

So little attention had been bestowed on this subject even by the most intelligent land-owners, that Miller, in the quarto edition of his Gardener's Dictionary, published in 1771, names only two varieties, and founds the distinction of these not upon quality, or time of coming to maturity, but on the trifling accident of a red and of a white colour, which is found to be productive of no other difference. At present, however, the varieties are so numerous, without any reference to colour, that it would be equally vain to attempt their description within any limited compass, as it is unnecessary to point out their uses, or enumerate their properties.

Not many years after the appearance of Miller's valuable work, the potato began to form an important article of English husbandry; and in the year 1796 it was found that in the county of Essex alone seventeen hundred acres were planted with this root for the supply of the London market.

The culture of the potato is now so extensive in this country, that an abundant supply can be obtained in all places throughout the year, and such have been the improvements in the culture, and the varieties to which these improvements have led, that a succession is furnished fresh out of the earth for nearly six

months in the year. The early sorts have been the reward of horticultural skill now so successfully exerted in this country; under the shelter of frames, with careful management, the tender young plants are made to struggle through ungenial weather, and to produce tubers at the earliest approach of summer.

The culture of the potato in the rest of Europe appears to have attained to no great extent until during the last century. In the latter half of this period it was made in more than one country a subject of interest and inquiry. Several works published about that time, treating on its culture, are to be found in both the French and German languages. From one of these, we learn that the potato was introduced from England into the Netherlands; and was thence transplanted into some parts of Germany. It was first cultivated in Sweden in 1720, but, notwithstanding the exertions and recommendations of Linnæus, it did not come into general cultivation until 1764, when a royal edict was published for the encouragement of this branch of husbandry.

The potato was still unknown to the agriculturists of Saxony so late as 1740; but so rapidly did its culture increase, that less than thirty years after the above date, a small detachment of the French army, while in that country, having its supplies wholly cut off, the soldiers subsisted for eight or ten days entirely on potatoes obtained from the fields; nor was this manner of living considered among them as by any means a hardship.

The Swiss discovered the value of this cultivation about the same period in which it was introduced into Sweden, and in a few years they not only grew potatoes among their mountains in abundance, but had likewise learnt the art of drying them, grinding them into flour, and making them into bread. A traveller in 1730 relates that the miller of Untersen had scarcely anything to grind but potatoes; and in 1734 a peasant was so well aware of the profit arising from this culture, that he bought a small field situated near the Swiss mountains, and in only two years after paid the purchase money by the produce of his potato crops.

It is said by another writer, about the same period (1770,) that during the twenty-five or thirty years preceding, the culture of this root in some parts of Switzerland had so much increased, that it constituted the food of two-thirds of the people. In the present day it still forms a principal article of food among the peasantry of that country.

It likewise makes a very prominent figure in the husbandry of Poland, where it is cultivated to an extraordinary extent. In 1827, as much as 4,288,185 korzecs, (about 2 cwt.) of potatoes were produced in that country, while 4,439,399 korzecs of rye were reaped, 3,183,023 of oats, 4,506,062 of barley, and 751,076 of wheat.

The cultivation of the potato has been of late years introduced into some parts of India with every prospect of success. In Bengal, especially, it has been attended with the most satisfactory results. Bishop Heber, in his interesting Journal, notices in several places the progress of this culture, the crops becoming by degrees more and more extended. These roots were at first very unpopular, but they have gradually gained favour, and are now spoken of as being the best gift which the natives ever received from their European masters. They are, we are told, held in much esteem, "particularly by the Mussulmans, who find them very useful as absorbents in their greasy messes." The following observations are gathered from the same volumes. In the neighbourhood of Patna many descriptions of European vegetables are brought to market in abundance; they are, however, reared for the consumption of the European inhabitants alone, the natives rejecting all but the potato, which, though known only since the last few years, may perhaps soon take its rank with rice and plantains, as a substantial article of food with the frugal Hindoo. It is already largely cultivated in that district, but can never become an exclusive crop, inasmuch as those humid stiff soils which are peculiarly favourable to the growth of rice, are wholly unsuited to the potato, the cultivation of which must therefore be confined to those sandy and drier soils, which are inimical to the culture of the rice plant. In such situations this vegetable of English production may be raised with unmixed utility, while the resource of so important a supplementary crop may, in seasons of the failure of the rice harvest, avert the evils of famine, and diminish, in one strong point of view, the resemblance between the Indian and Irish peasantry, their reliance on a single article of food. The almost infinite division and subdivision of their farms is in India, as in Ireland, a fertile source of poverty and wretchedness.

The observations of another intelligent writer on the same subject likewise tend to show the advantages which may result from this cultivation in Hindoostan. He remarks that a dry season is prejudicial to the rice crop, while it is favourable, or rather not so hurtful, to that of the potato, and "therefore nature points out the one crop as a substitute when the other fails." It is certainly a fortunate circumstance that the superstition by which the Hindoo is enslaved does not shut up every avenue to innovation and improvement. No religious prejudice forbids the culture of this vegetable, and therefore the natives evince a readiness to adopt it in all situations where it can be as easily obtained as other

food. The soil of Bengal, and the long continuance of dry weather, may, perhaps, be obstacles sufficient to prevent this root from becoming the principal nourishment of the lower orders; but it is supposed that if it could be raised cheaper than rice, the potato would be generally preferred by Hindoos. At present it is almost universally served up at European tables in Bengal in the same manner as in England; and though the crop is less abundant, and the roots are smaller in size, they are scarcely inferior in quality to those of this country.

Wherever the Englishman seeks a home, he always strives to naturalize this root, which was so long struggling into notice in his own country. Now amid all the luxuriant and delicious vegetation of tropical climes, he still retains his preference for that simple vegetable, which he considers almost a necessary of life. At Ceylon all his attempts to cultivate this plant have been nearly vain, as it will not thrive in that island at any place except at Candy, a town almost seventy miles in the interior, and the only spot in the country where European vegetables come to any degree of perfection. A basket of these roots is sent every morning thence for the supply of the governor's table, as all the indigenous vegetables are considered an inferior substitute for this necessary auxiliary to the Englishman's more substantial fare.

There are a great many varieties of the potato, arising from soil, culture, and other circumstances, but even in the same soil, and under exactly similar circumstances, there are few plants which exhibit such endless diversities as this one, especially in the size, form, and colour of the tubers. It will be sufficient to mention a few of these varieties.

The Spanish or *White Kidney*, is an oblong flat potato, of a yellowish hue when boiled; dry or mealy, and of an early sort.

The Wicklow Banger, is a very long flat root, with very few eyes, and those scarcely sunk in the surface, with a rose-coloured spot on one end and sometimes on the side; an early kind much esteemed in Ireland.

English White, or *London lady*, a smooth fair potato, generally flat, at first watery but afterwards dry and mealy.

The White Eye, a large round root, of a red colour, with the eye sunk very deep in the white blotches; a productive kind and moderately dry.

There are other varieties of a deep purple colour, and of a bright red or mottled appearance.

All these varieties are produced from sowing the seeds.

Potato plants raised from seeds do not blossom for the first three years, nor are the potatoes fit for use until replanted for two or three years, unless care be taken to sow the seeds in rich ground in small drills, and afterwards transplant the shoots and frequently hoe them.

It is perhaps of advantage thus occasionally to rise potatoes from seed in order to obtain fresh tubers and new varieties. But if care be taken to change the soil of the tubers every other year, that is, to procure seed potatoes from a distant and different locality, the healthy perfection of the plants may be indefinitely prolonged.

With regard to the best soil, the uplands and the lighter grounds are found to be much better adapted than rich and strong lands to the cultivation of the potato. This root has one great advantage over all grain and leguminous crops, in being perfectly secure against the late rains, which often completely destroy the hopes of the farmer. Rains which have no bad effects upon the potato, injure the bloom upon the cerealia, or cause them and the legumes to run so much to straw as not only to be less productive of seed, but actually to lodge and rot. The quality of the roots is no doubt a little deteriorated by excess of moisture, but when they are sufficiently matured, rain has little or no injurious influence over them.

This plant seems alone to have been wanted to make the agriculture of the British isles complete. Upon the western side, and among the mountains, a grain crop is always precarious, and seldom or never good. Scanty and bad as it is, its culture is also expensive, as, after it has been reaped, it cannot be left in the field to dry, but must be taken wet into barns constructed of wicker-work, for the purpose of obtaining a current of air, and there suspended upon ropes. Such a process is not merely tedious and costly, but absolutely incompatible with the culture of any considerable quantity of grain.

A new soil produces better potatoes than worked land in the highest condition; and ground which is light and spongy, provided that it has the advantage of plenty of moisture, which does not stagnate, is better than the strongest lands. The reasons are obvious—the tubers will form with the greater ease according as the resistance is less which the ground offers to their expansion, while so large a quantity of vegetable matter elaborated in so brief a space demands no little supply of humidity. Now the little patches among mountains are composed of the very best soil for this purpose, being generally a mixture of sand and vegetable matter. Such a soil is readily penetrated throughout by every shower, and yet the water does not stagnate; as a mountainous country near the sea is, in high latitudes, always one in which there are frequent showers, the watering of these mountain patches is precisely that which is most beneficial, and therefore it would be difficult to imagine a soil and climate better fitted for the growth or for

producing excellence in the quality of these tuberous roots.

When cultivated in tenacious argillaceous soils, if the summer be dry, the swelling of the tubers is prevented by the mechanical pressure of the earth; and on the other hand, such soils, if constantly in a state of moisture, produce immature tubers, which are sodden, waxy, and otherwise of bad quality. But in ground which to all appearance is little else than loose sand, if there be humidity enough, potatoes will grow and be of excellent quality, and, even should there be any failure in the sufficiency of moisture, the quality of roots yielded by the first planting will be good, but they will be small, and too hard for propagating. In the mountain districts of Scotland the frequent rains in all seasons are of so constant recurrence, that a whole week of dry weather is considered worthy of record. This circumstance, so unfavourable to the maturity of other crops, operating in union with the peculiar nature of the soil, causes the situation to be well adapted to this cultivation: while there are still other advantages on the west coast of the Scottish Highlands, and which apply in a great measure to Ireland. In the first place there is very little frost—never any except in high and comparatively inland places—until the potatoes are come to their proper growth. Again, spade husbandry is best adapted for potatoes, and it is also the best for those places where the acclivities are generally too abrupt, and the spots of land really worth culture too small to admit of the use of the plough with any advantage. Persons who are accquainted with only flat countries, where there is little inequality of soil in a field, and no absolute sterility in a parish, but that which is consequent on neglect, can form but an imperfect idea of the variations witnessed in a little portion of mountain land. In a section of thirty yards there may be ten yards of useless gravel in which moisture can find no resting-place till it be fathoms deep in the ground, ten where there is not above three inches of soil on the bare rock, and ten of soil of the very best quality. The first and second portions would not of course produce a crop of any description, and yet in the use of the plough it would be necessary to pass over them, or to lose about the same time in turning; so that the expence of ploughing such a piece of land would be triple that of ploughing the same extent of a champaign country. On the other hand, when the spade is employed, the culture of the fertile spots is not more expensive than if they were continuous, and situated on the flattest surface in the island; while the nature of the soil renders the labour of turning it and taking up the crop comparatively easy.

Thus the potato has this great and peculiar advantage over all other substantial esculent vegetables, that it can be not only cultivated in places where no others can be profitably grown, but that it can be cultivated there at small expense; while it is less subject to disease, and more secure against degenerating in those situations than on richer lands. Consequently, in a soil so diversified as that of Britain, and where the communication between any two places is so easy, an almost unlimited supply of potatoes may be grown without any diminution of the breadth of profitable crop of the cerealia, the legumes, or indeed of any other useful plant; while this crop is recommended as causing an amelioration rather than an exhaustion of the soil.

The most usual and profitable manner of propagating this vegetable is by putting into the ground the tubers, either whole or divided into as many parts or *sets* as they contain eyes. The sets are planted in lines from twenty to twenty-four inches apart, either in drills or by the dibble, at intervals of from twelve to fifteen inches. The proper season for planting the main crop is from the 1st of April, till the middle of May, and a peck of seed potatoes is usually required to plant a bed of twelve feet by thirty-two.

It seems generally admitted, that the cuttings should be made from large but not from overgrown potatoes, and that it is not profitable to plant either small potatoes or small cuttings. A good set, part of a large potato, all other things equal, will naturally produce a stronger and better plant than part of a small potato, the crop being in general proportioned to the weight of the sets. They ought to weigh about two ounces each, and should not be such small cuttings as thrifty managers are so apt to employ. A large cutting gives nourishment to the plant when young, which promotes their future growth. Mr George Lindly says, "the earliest tubers of the potato are always those which have been produced from sets which have been cut with a single eye to each. This circumstance should be particularly attended to in the first crop, as I have always found these ten days or a fortnight earlier than those produced from sets which had been cut with two or more eyes. I have tried them several years, planting the single-eyed sets in alternate drills with the others, and the difference has proved uniformly the same."

In Lancashire they are convinced that the best plan is to cut off the front or nose end, and also the umbilical or tail end of a large potatoe, and rejecting both, to take the middle part entire for planting. The common practice of cutting the potatoe down the middle, from nose to tail, is not to be recommended.

The advantages of large cuttings are satisfactorily proved by an experiment tried by Mr Whyn Baker, in Ireland. He planted three

sorts of cuttings, 1. reasonably large; 2. very small; and 3. very large; the result was,

	Produce. lb. oz
1. The reasonably large, or moderate sized, produced	84 3
2. The very small, ...	64 12
Difference,	19 7

This, upon an acre, would make a very material difference. The produce of the very large was little or nothing different from the reasonably large or moderate sized.

The mode of managing the sets requires more attention than is commonly paid to it, more especially for early crops. In regard to them, the following is the most approved method in Lancashire. When the sets are cut, they are put on a room-floor, where a strong current of air can be introduced at pleasure, two lays in depth, and covered two inches thick, with chaff, or sawdust. If desired to be very early, they remain thus from November till March, much attention being paid to give or to exclude air, according to the weather.

If the seed, after being cut, is suffered to lie in a heap, *it will heat*, and it will either be totally destroyed, or at least so weakened as to produce *curled stalks* and a poor crop. Curled stalks will proceed from any other cause which weakens the vegetative power either before sowing or when the plant is in a state of growing; but nothing can more effectually produce it than laying potatoes together in too large quantities, in a wet or damp state. This must occasion repeated sprouting before planting, and perhaps worms may be produced, which, wounding the young shoots, may occasion much mischief.

It is said that a set will not sprout until the cut be healed; and, therefore, if the cutting be performed long enough before the setting, to allow time for the cut to heal or dry, so much time will be gained by the planter, which is a great object, especially to the poor, who are late in planting.

The quantity of seed per acre varies from fifteen to thirty bushels; medium about twenty, which is quite enough if the rows are kept at an adequate distance from each other, namely, four feet. Nothing can be more injudicious than the close planting so prevalent in many parts of the kingdom, and more especially in the more northern districts.

Some recommend the plan of planting the entire potato; but the saving of the seed, by cutting large potatoes, is considerable, amounting to £1 19*s*. 8*d*. per statute acre; for it appears, by repeated experiments, that the uncut potatoes required 37½ bushels per acre, and the cut only 20½, making a difference of not less than seventeen bushels.

Some years ago a gentleman in Fife tried the following experiment: He took one of the largest potatoes he could get, and planted it whole in his garden without dung; the produce was seventy-two potatoes in all; above twenty of them were nearly as large as the mother-plant, the remainder of different sizes, gradually decreasing to about the size of a walnut. Next season he planted the whole of that produce also uncut, setting the largest in the front row, the next largest in the second, and so on, diminishing the size in every row till the last, which was the smallest of all. By this experiment he found not only that the stems of the largest seed were by far the strongest, but their produce was also by far the greatest, none of them producing potatoes larger than their respective seed. From this it would appear that the larger the seed-potato, the larger will be the produce. Whether the original potato would have produced an equal weight, had it been cut in three or four sets, he could not say; but unless it would have produced a great deal more, the advantages are certainly in favour of setting them whole, by saving a deal of labour, and occupying a less space of ground.

It is well known that in the spring potatoes shoot out, and that in stirring, moving, or cutting slices, many of these shoots fall off, and are commonly thrown away. They may, however, be preserved and planted with success, instead of cuttings; by which means there is a saving of seed to a certain amount. Although it is highly proper carefully to preserve all the sprouts which can be collected in the sowing season, yet the entire substitution of sprouts in the place of potatoe-sets can never take place so as entirely to supersede the necessity of planting a considerable quantity of the latter. Every man's experience proves, that when sprouts are put forth the potatoes are considerably weakened, and that *that* weakness increases in proportion as sprouts appear, until the potatoes are entirely exhausted, and unfit either for food or seed. The general practice therefore is, to prevent as much as possible potatoes from sprouting at all; and when that cannot be done *effectually*, farmers choose to let the sprouts remain and wither, which they will do by turning the potatoes often, shaking the mould off, and keeping them in a dry state. The withering of the sprouts, it is said, prevents or retards new shoots, by which the potatoes are preserved in a better state for food than if they were encouraged or suffered to put forth many sprouts. But supposing all the sprouts of potatoes which are brought to view during seed time be preserved for seed, yet the quantity of good shoots will fall *far short* of the complement necessary for a general planting, inasmuch as a potato, however large and full of eyes, will not, at the first sprouting, put forth more than *one or*

two shoots. It is to be considered also, that the poor people's sowing of potatoes seldom commences until May, and continues but a short time; so that were they to plant nothing but *sprouts*, their stock of potatoes should be much larger, to produce a sufficiency of sprouts, than they generally possess, or have occasion for at that season.

Sprouts are fit for planting at any time after they acquire roots sufficient to support themselves, independent of the mother-potatoes, which they generally do when about three inches long. Sprouts may be planted successfully in all the various methods by which potatoes are usually planted; but it is not advisable to have the sprouts *cut in pieces.* It is better to plant them whole, be they ever so long, or have ever so many series of roots and joints. When left whole, they may be planted at greater distances. They answer best when laid *horizontally*, covering them in every instance as potato-sets are treated.

It is said that potatoes, and the sprouts of potatoes, have been planted on the *same day*, and that sprouts came up about three weeks *sooner* than the potatoes. It is likewise maintained that sprouts will produce as good, if not better crops, than potato-sets, and more seldom fail of growing; so that this branch of the subject still requires additional investigation.*

The young plants are kept free from weeds, and when they are about half a foot or a foot high, some earth is drawn around the lower part of the stem; little or no farther care is required till the taking up of the crop. The plants are suffered to remain until the roots attain to their full growth. This state is indicated by the stalks beginning to decay, which usually takes place at the commencement or latter end of October, when the roots should be dug up for the winter store. Some careful cultivators pinch off the blossoms as they appear on the plant. The good effects of this practice have been very often proved, it being supposed that the weight of the tubers of each plant is increased an ounce in consequence, or considerably above a ton per acre. The cause of this result has been thus explained: the fluid or sap gives sustenance alike to the tuber and blossom, and, therefore, if a portion be diverted from the formation of the blossom, it will be exerted for the enlargement of the root.

This plant may be propagated also from cuttings or layers of the green shoots; but this is not at all advantageous for any culture, except in some instances, when it is required to multiply as quickly as possible a rare sort.

The tubers obtained from seeds are at first very few and very small, and therefore seed cultivation is by no means advisable to "the grower" of potatoes; but it is of great service to "the breeder," who seeks to improve its quality.

On the other hand, by cultivation from the tubers a good variety may be extended and preserved after it has been once obtained; as the plant from the tuber is not a new plant, like that which is procured by the operations of flowering and seeding, but an identical part of the old one. Though the planting tubers will not lead to any new variety, it may have effects every way as advantageous, for no plant profits more by changes from one district to another.

Besides improvement in quality which a judicious change produces, it likewise often prevents the most destructive disease to which the potato is liable. That disease is known by the technical name of the *curl*, or the *curl-top*, a name by no means inexpressive of the appearance of the plant when under its influence. The top leaves begin to shrink just about the time that the tubers should form, the young shoots cease to expand, and the whole plant assumes very much the appearance of the tip of a cherry twig when the under leaves are assailed by aphides. From the moment in which this disease appears, all farther growth in the plant ceases, and though it may linger in a yellow and sickly state until autumn, the produce, if any, is little, and that little is of a bad quality. If, as soon as the disease shows itself, the tuber which has been planted be taken up, it will be found much firmer and less exhausted than those of the plants of the same age that are in a healthy state. This at the same time points out at least one cause of the disease, and suggests its remedy. The old tuber has been too compact for yielding to the vegetative powers of the plant.

The curl first made its appearance in this country in the year 1764, in Lancashire, where potatoes had been first introduced into British field culture, and had been propagated without any change of seed. From Lancashire this disease spread over all the potato districts of Britain, and as the cause and cure were equally unknown, there was a general apprehension that the plant would be exterminated. Premiums were offered by different agricultural societies to those who should point out a remedy for a disease so destructive; in consequence of which many speculations and theories were raised, which, however, led to very little practical utility.

The discovery of at least a temporary preventive, and therefore of the probable cause, was made, as is believed, more from accident than design, in the neighbourhood of Edinburgh. Some of the growers in that situation were in the habit of procuring seed potatoes from the cold moorland districts, and fields planted with these were free from the curl. Upon inquiry it was found that in those bleak and humid situations the po-

* Sir John Sinclair on the Potato.

tato crop was so late that the frost came on and blackened the leaves, while they and the stems were still green, and the tubers of course not ripe. The change of climate was therefore not the sole cause of prevention, if indeed it was the cause at all, for when the full ripened potatoes were planted in the moors, the curl appeared in them, in situations where there was none in the native potatoes. It was thus found that the curl could be prevented by using tubers that were not quite ripe.

A writer in the Gardener's Magazine for May 1827 thus ingeniously accounts for this fact: "The potato tuber is a perfect organized system, in which the circulation regularly proceeds, and if suffered to ripen will then tend to decay; but if separated before ripe from the stem or stalk which furnishes it with blood or fruit-sap, descending from the leaves, the circulation of the blood-sap is suddenly arrested. The ripe potato, having performed all its operations, becomes more inert; but the circulation of the sap in the unripe tuber having been stopped, it starts more readily, and with greater vigour, when planted; the one appears to die, worn out with age, the other seems accidentally to have fallen asleep, and when awakened, possesses an unspent vigour and energy."—p. 317.

That over-ripeness is the principal cause of the disease, has been found by experience to be so much the case, that out of the same potato it is possible to make some sets that will, and others that will not, produce the curl. The portion of the tuber that is nearest to the cord by which it is fastened to the plant, ripens first, as any one may observe, especially in an elongated potato, where the root end is often so mealy as to fall to powder, when the top or thick end is soft and waxy. If such a potato be taken when only the small end is ripe enough to boil mealy, the eyes upon another of the same parcel that are upon the waxy part, will all produce sound plants, while curl may appear in those which are taken from the mealy end. The soil and mode of culture may have likewise some effect in producing this evil. Experience has shown that high culture and stimulating manure tend more to produce curl than poorer treatment; that this disease is less frequent in new lands than in those which have been long in culture; and that it seldom appears in cold and upland places.

The following facts, collected by the late Sir J. Sinclair, on this important subject, deserve attention. About the beginning of October, a gentleman took his potatoes out of the ground, put them upon some straw in a vault in the cellar, and covered them with straw on the top, where they were left for the winter. It was impossible for frost to approach them. In the succeeding February a friend requested a few of them to plant. Accordingly, about a bushel were taken from the store, and put in an outhouse in the yard, where they remained for some time, during which there were several severe frosts. It was evident that the frost had affected them; and the gentleman therefore determined to try what effect it would have upon them. They were planted; and the consequence was, that one-half of them had curled leaves, and was not half a crop. Those which remained in the vault until they were planted were not *in the least* disordered. Many other causes may doubtless produce this disorder; but the foregoing experiment clearly demonstrates, *that frost will cause it*, and ought therefore to be most carefully guarded against.

There is reason also to believe, that the frequent application of lime to the soil will occasion this disease, of which the following experiments furnish a strong proof: A piece of ground (deep loam) was well manured with lime, and planted with potatoes. When the plants appeared above ground, nearly three-fourths of them were curled; while at the same time a few drills, immediately adjoining, which had got no lime upon the soil, and planted with the same seed, were entirely free from the distemper. This circumstance attracted notice, and the same experiment was repeated next year, with the same result.

Any cause that weakens the plant must certainly occasion the curl; but there is nothing to which it can be more justly attributed than to the sets lying in heaps in a house, and being suffered to heat before they are planted. On the other hand it has been remarked, that when potatoes, to be used as seed, are kept in pits under ground, and not in a house, the crop is seldom liable to that distemper.

The best means of avoiding the curl is, to change the seed every second or third year, as from moss land to cultivated soil, and *vice versa*. It is a practice of the Lancashire planters to send some of their favourite kinds to the mossy grounds to recover, if they are found to have a tendency to curl; and it is certain that potatoes from mossy lands will not curl. The moor lands in Yorkshire, and the mountains of Radnor and Montgomery, are free from curl, while the vales are infested with it.

It has also been found, that sets taken from young potatoes are not so liable to the curl as those which have been forced to a great size by rich manure and earthing up; and some farmers on purpose sow the potatoes intended for seed later than the rest, that they may not attain great size or maturity.

The economy of this article of food, as compared with wheat, is seldom questioned, although doubts have been raised even as to its comparative cheapness with wheaten bread. The fol-

lowing statement, from Mr Jacob's Corn Tracts, contains all the facts that can be depended upon for forming an opinion on this question: "If an acre of land, with the same degree of labour bestowed upon it, and the same portion of manure applied to it, yields 300 bushels of potatoes, it may yield 24 bushels of wheat. The food produced by the former, at 38 lbs. to the bushel, will then be 11,400 lbs. in weight; the food from the latter, at 60 lbs. to the bushel, will be 1,400 lbs., or the weight of the wheat will be one-eighth that of the potatoes. It is difficult to ascertain the quantity of nutrition in a given quantity of either wheat or potatoes. The chemical experiments of Sir Humphrey Davy show that wheat contains about three times the quantity of mucilage or starch, and of gluten or albumen, of what is contained in a like weight of potatoes; but that potatoes contain also about from three to four per cent. of their weight of saccharine matter, in which wheat is deficient, though it abounds in barley. The difficulty of estimating the nutritive power of the two substances is not wholly removed by this appeal to chemistry, because we are still ignorant of the effect which the combination of the saccharine matter with the mucilage and gluten may produce when used as aliment. A small addition of the former to the two latter may communicate to the whole mass a degree of nutritive power very far exceeding its own separate proportion of weight. Some inquiries have been made as to the actual quantity of potatoes consumed per head in families in Ireland, in Prussia, and in Saxony; but the answers varied to such a degree as to be little satisfactory. It does not appear to me to be very far from the fact, if we estimate the proportion of the nutritive power of wheat to that of potatoes, as about seven is to two; or that 2 lbs. of wheat afford as much subsistence as 7 lbs. of potatoes, though it may be doubtful if it affords as much nourishment. We have seen before that the mean weight of the two kinds of food, from the same extent of land, is nearly as one to eight; and now assume that the consumption of an individual is yearly one quarter, or 480 lbs. of wheat, or an equivalent quantity of potatoes being 1680 lbs., then one acre of wheat will produce sustenance for three persons, or one acre of potatoes will afford it to six and five sixths."

The chemical composition of the potato is as follows: 100 parts, deprived of the skin, contain

	Parts.
Water,	68 to 72
Starch,	17 to 15
Fibrous matter,	9 to 8
Extract, or Soluble Mucilage,	6 to 5

There is also a small proportion of Potash and of an Essential Oil.

The farinaceous matter of the potato may be preserved in a dry state by two processes. The one consists in washing the roots well in water, then subjecting them to the temporary action of steam, by which the skins are readily detached, and finally slicing them into thin pieces, drying them, and grinding the whole into a powder. Of this, bread may be made by an admixture of wheaten flour or oatmeal. The other method is to grate down the potatoes into a pulp, either by a hand grater, or a machine constructed for the purpose. This pulp is then repeatedly washed with water till the whole of the fibrous and mucilaginous matter is cleared off, and the pure farina or starch remains in a white and insoluble powder at the bottom. If sufficient pains are taken by repeated washings, this farina is of a perfectly pure and unmixed nature, and equal to that procured from wheat or the other farinaceous roots. This starch, mixed in certain proportions with wheaten flour, forms a palatable bread; or it may be used for all purposes for which arrow root is employed.

Sugar has also been manufactured in France from the potatoe, and a syrup like treacle. This treacle, says Mr Jacob, appeared to me as sweet as any from the tropics, the only perceptible difference between them was, that it had less consistence. By fermentation a kind of spirit may also be distilled from this root.

Sweet Potato, *(convolvulus batata;)* an herbaceous perennial plant, belonging to the natural

113.

The Sweet Potato.

family *convolvulaceæ*, and to the order *pentandria*, and class *monogynia* of Linnæus. The term Batata, according to Rumphius, is of Malay origin. It is also called skirrets of Peru. It is a native of both Indies, as also of China, in all which countries it is generally cultivated; and much esteemed, not only for its tuberous roots, but for the young leaves and tender shoots, which are boiled and eaten.

The sweet potato is a low trailing plant; the stems are creeping, jointed, and extend from the central root about six or eight feet. They are of a pale green colour, and at each joint give out roots, which are oblong tubers of considerable size, according to the soil and climate. The leaves arise from the stem by long petioles; they are of an

angular shape, and irregularly notched. The flowers are of a purple colour. There are several varieties of the cultivated plant, depending upon soil and climate. In tropical countries, of which it is a native, the roots attain a considerable size, and sometimes fifty are found attached to one plant. The roots, when roasted or boiled, have a sweetish mucilaginous taste, more watery and more insipid than the potato, but wholesome and nourishing. It is of very easy cultivation, and very prolific; all that is necessary is to lay down the young shoots in spring, and strew a little earth over them; if this is followed by a shower of rain, they will immediately spring up and grow luxuriantly. The roots also, if planted, will readily throw out fresh shoots in abundance. The batata is raised in hot-houses in the Garden of Plants in Paris, and the young plants then put into the open ground, where they thrive well, and are productive in favourable seasons. Sir Francis Drake and Sir John Hawkins introduced this plant into England in the middle of the sixteenth century, bringing it from Brazil, of which country it is a native; but although attempts were made to naturalize it to our climate, it was found too tender to endure the cold of winter, except in hot-houses. Previous to the general use of the common potato, considerable quantities of the batata were imported into England from Spain and the Canary islands; and this is the potato alluded to by Shakespeare and other contemporary writers. Its use is now greatly superseded by its more hardy and palatable rival. In tropical climates, however, it is still esteemed as a wholesome and pleasant vegetable. In many parts of South America, especially in Guiana, it forms a principal article of diet. The Indians, too, also produce from its fermented juice a kind of spirit, of which they are fond. The leaves are relished by cattle, and prove to them a most nutritious food. Cows fed on this foliage produce a larger portion of milk, and of an improved quality.

Jerusalem Artichoke *(helianthus tuberosus)*. This plant resembles the common sun-flower, to which order it belongs. It is a herbaceous perennial, growing to the height of three or four feet. The tubers are oblong, and of the size of a common potato. They have a sweetish farinaceous nature, somewhat akin to the common potato, but contain less farina, and more saccharine matter and water. This plant is a native of Brazil, and was introduced into Europe about the year 1617. It is cultivated in the same way as the potato, by planting the small tubers in February or March, in rows four feet apart, and the sets eighteen inches from each other in the rows. In order to have the roots handsome, they should be taken up and transplanted into fresh ground every year, otherwise they are apt to degenerate.

Cassava *(jatropha manihot)*. A woody plant, a native of Brazil, growing to the height of five

114.

Cassava Plant.

or six feet. Its root is woody and branched, with a number of small fibres, which swell out into small farinaceous masses, from which the cassava flower is procured. The stalk is slender, woody, and knotted. The leaves are smooth, palmated, increasing in breadth to within an inch and a half of the top, when they diminish to an acute point. When it is considered that this plant belongs to a highly poisonous tribe, and is itself one of the most virulent of the species, it cannot but excite astonishment to find that it yet yields an abundant flour, which by the art of man becomes not only perfectly innocent, but highly nutritious, yielding nourishment to many thousands of the natives of South America, and affording a luxury to the tables of more refined Europeans. Such is the poisonous nature of the juice of the mandioc, that it sometimes occasions death in a few minutes; and in this way many of the unhappy Indians destroyed their Spanish persecutors. A Surinam physician administered it, by way of experiment, to dogs and cats, which died after twenty-five minutes in dreadful agony. Dissection proved that it operated by means of the nervous system alone; an opinion confirmed by thirty-six drops being afterwards given to a criminal. These had scarcely reached the stomach, when such torments and convulsions ensued, that the man expired in six minutes. Three hours afterwards the body was opened, when the stomach was found shrunk to half its natural size, so that it would appear that the poisonous principle resides in a volatile substance, which may be dissipated by heat, as indeed is satisfactorily proved by the mode of preparing the root for food.

When the climate is favourable, the plant is of a hardy nature and of easy culture. It, however, requires the land to be of good quality; and the same spot cannot well be employed to yield two crops of it in succession. It needs a dry situation for its most successful cultivation; and when spots of a different nature are applied to

the purpose, precautions must be taken, by raising hillocks whereon to set the cuttings, against the effects of excessive moisture, which would rot the plants: some moisture is, notwithstanding this, needed by the plant at its earliest stages.

There are nine different species of jatropha enumerated by botanists, only two of which are cultivated for human food, the *jatropha manihot*, or bitter cassava; and the *jatropha janipha*, or sweet cassava.

The first of these varieties, when in its natural state, is highly poisonous; while the other, although equally agreeable and wholly innocuous, is yet not cultivated to anything like an equal extent. The two roots are very similar in appearance, their only perceptible difference being a tough, ligneous fibre or cord running through the heart of the sweet cassava root, which the bitter variety is wholly without. Bread is made of both kinds, which is palatable and wholesome; and although its taste may be thought somewhat harsh by persons accustomed to soft fermented bread made from wheaten flour, cassava bread is not without its admirers, and is in such high repute with those who have been accustomed to its use, as to be frequently procured at some expense and trouble by Creole families who have transferred their residence to Europe.

The tubers are spindle-shaped, much resembling parsnips in appearance; they are generally about fourteen or fifteen inches long, and four or five inches thick at the middle. When first dug out of the ground they are washed clean; the rind, which is of a dark colour, is then peeled off, and the root is ground or grated. In Guiana the mode of preparation is as follows: The root is rasped in large tin or wooden graters, fixed on benches, behind which the women employed in making it stand in rows. A sufficient quantity having been rasped for one time—for the surplus would ferment and spoil—it is put into long circular baskets of plaited rushes, about ten feet long and nine inches in diameter, called *mangueras*. These are hung up with weights attached to the lower end, which draw the plaited work tight together, diminishing its capacity, and squeezing out the juice. When all the fluid is extracted, the mangueras are emptied of their contents on raw hides laid in the sun, where the coarse flour soon dries. It is then baked on smooth plates made of dry clay, with a slow fire below. This is the most difficult part of the process. The coarse flour is laid perfectly dry on the hot plates, where the women, with a dexterity only to be acquired by practice, spread it out in a round and very thin layer, nearly the size of the plate it is laid on. This they do merely with a piece of calabash, which they keep in constant motion, pressing gently every part of the surface, until the heat has united the meal into a cake, without in the least altering its colour or scorching it. Their method of turning a cassava cake of that size resembles slight of hand, for they effect it with two pieces of split cane without breaking it, though scarcely so thick as a dollar, and only as yet half cemented together, and of a substance always brittle, especially when warmed. This bread is very nourishing, and will melt to a jelly in a liquid; but it is dangerous if eaten in any quantity when dry, as it swells on being moistened to many times its original bulk. It will keep good for any length of time if preserved in a dry place. The expressed juice deposits, after standing for some time, a fine white starch, which, when made into jelly, is not to be distinguished from that prepared from the arrow root.

To whatever cause the poisonous quality of the juice of bitter cassava may be owing, it is so highly volatile as to be entirely dissipated by exposure to heat. Even a comparatively low temperature suffices for correcting its deleterious nature; for when the root has been cut into small pieces and exposed during some hours to the direct rays of the sun, cattle may be fed on it with perfect safety. If the recently extracted juice be drunk by cattle or poultry, these will speedily become much swollen, and die in convulsions; but if this same liquid is boiled with meat and seasoned, it forms a favourite soup, called by the Brazilians *casserepo*, and which is found to be wholesome and nutritious. Dr Pinckard mentions having partaken of this soup in Demerara.

Stedman acquaints us that the Indians of Guiana, among whom cassava forms the chief bread, first grind the root on a rough stone, and then, for the purpose of separating the juice, prepare a curious kind of press out of reeds, which being disposed in the form of a long tube, and secured at bottom, the ground pulp is introduced, and the press being suspended to a tree, a heavy stone or log of wood is fixed to the bottom, the weight of which draws the tube gradually together, by which means the juice is squeezed through the interstices. Occasionally the juice is collected into a receptacle, and is then used for the poisoning of arrows. The baking process of these inhabitants of the woods is similar to that described above, with this only difference, that, being without iron plates, their cooking is performed upon heated stones.

The Indians eat the simple root after having roasted it in hot ashes, without any subsequent preparation. They also ferment the juice of the plant with the addition of molasses, and produce an intoxicating liquid, of which they partake but too freely. This knowledge they possessed before they were ever visited by Europeans, thus affording one out of many examples of the almost universal use among nations, however differently situated, of some kind of stimulating and intox-

icating drink or another. The leaves of this plant are also boiled and eaten by the Indians.

Such is the productiveness of the cassava plant, that it has been calculated that an acre planted with it will yield nourishment to more human beings than six acres of wheat.

The *tapioca* of this country is the produce of the cassava root. It is in every respect identical with pure farina.

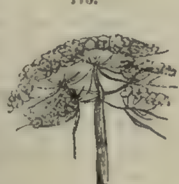
The Pia *(tacia pinnatifida)*. This is an herbaceous plant, indigenous to the South sea islands, from the dried roots of which the natives prepare a farinaceous substance, very much resembling arrow root. The plant grows wild, but is also cultivated in their gardens. In preparing the farina the root is first beaten to a pulp, and subjected to repeated washings, by which it becomes tasteless and colourless. It is then dried in the sun, and becomes fit for use.

CHAP. XXXI.

UMBELLIFERÆ, INCLUDING THE CARROT, PARSNIP, &c.

Under the natural family of umbelliferæ, are comprehended a number of edible roots and culinary plants of considerable importance, as articles of food. The same family contains, however, plants of a very opposite nature, possessing all the properties of acrid and virulent poisons. The members of this family are generally recognised by their hollow stems and deeply notched leaves, with a sheathing petiole. Their flowers are mostly white, or greenish sometimes, but rarely of a pinkish hue. The inflorescence is what is called umbellate, and the seed or fruit consists of two ribbed portions, which are joined together by a common axis, and a thickened discus. All are inhabitants of moist ditches or damp way-sides, in the colder parts of the earth, and temperate zones. In the tropics they are either extremely rare, or wholly unknown; and when present have generally a character different in most respects from the European species. The simplicity of their structure, and uniformity of their appearance, have rendered their classification a matter of difficulty. The culinary and agricultural importance of many species is familiar to all. The parsnip and carrot form a large part of the winter store of the inhabitants of Europe, as the *arrachaches* do of those of South America; and the *prangos* of Thibet is supposed to be the most important and productive of any in the whole world as a forage plant.

115.



P. 72.

The medicinal properties of some species of this family, of which we shall treat afterwards, are of various and powerful natures. While the seeds of some are aromatic and highly stimulating, the fresh roots of others are strongly narcotic and sedative. This has been supposed to arise from the difference in the state of the sap in different parts of the plant; and it has been thought that the narcotic principle is only to be found in the ascending sap; while the aromatic stimulating properties are found in the juices which are fully elaborated and matured. It is a singular fact that cultivation destroys the dangerous properties of some species. The common celery is a familiar example of this; but the most remarkable, a species of Œnanthe, a most poisonous kind, when wild, is cultivated about Angers for the sake of its roots, which are there called *jouanettes;* and about Samur, where they are known by the name of *mechons.* The roots of some umbelliferæ contain a large proportion of sugar; those of the carrot when dried, contain more than an eighth, those of the parsnip an eighth exactly; and those of the chervil about eight per cent. The umbelliferæ are a numerous family, and have been divided into nine tribes. They all belong to the Linnæan class and order *Pentandria digynia.* We shall in the mean time, describe those species which are used as food.

Earth Nut, *(bunium bulbocastanum.)* This is a plant very common on elevated and hilly grass pastures; hence its name of *bunium*, the Greek word for a hill. It has a few deeply pinnated root leaves, and a slender stem with a white cluster of flowers at the top. The tuber is found about four or six inches below the surface, at the termination of a long slender root. It is about the size of a chestnut, of an irregular figure, and covered with a brown cuticle. It is of a sweetish farinaceous nature, resembling in taste the common chestnut; being more amylaceous on being subjected to heat. Swine are very fond of them, and fatten rapidly where they are procured in abundance.

We do not know what effect cultivation might have in increasing the size and edible qualities of this root, or whether any attempts have been made to raise them artificially. It is not improbable, however, but that frequent transplanting and a genial soil, might render them worthy the attention of man, as an article of food.

The Carrot, *(daucus carota.)* The wild carrot is indigenous to Britain, and is found growing in waste plains and by the way-sides. Its root is small, hard, and fibrous, and of a white colour; the leaves and inflorescence are similar to the cultivated species. It is a matter of some doubt whether the garden carrot has been de-

rived originally from the wild species. Several horticulturists have attempted to cultivate the wild root, but without success. The probability is, therefore, that the garden carrot is either a distinct species, or a variety obtained in a warmer climate than that of Britain from a wild stock.

This root, according to the commentators, would appear to have been known to, and cultivated by the Greeks under the name of *staphylinos;* at all events, the description of Dioscorides seems to apply pretty accurately to the modern carrot. He describes it as a plant growing wild, but also cultivated for the purpose of an esculent root. The carrot also appears to have been a cultivated vegetable among various nations, from the time of the Greeks downwards.

The garden, or cultivated carrot, was first introduced into England by the Flemings, during the reign of Queen Elizabeth. Finding the soil about Sandwich in Kent very favourable for the culture of the carrot, the emigrants soon engaged in its production on that spot. The English, whose knowledge of horticulture was at that time extremely circumscribed, were in this case well pleased to add another edible vegetable to the scanty list which were then under general cultivation. The carrot, therefore, unlike the turnip, grew quickly into esteem, and being made an object of careful culture, was very shortly naturalized throughout the island. Parkinson, the celebrated botanist to James the First, mentions that in his time the ladies adorned their head-dresses with carrot-leaves, the light feathery verdure of which caused them to be no contemptible substitute for the plumage of birds. Although the taste of the fair sex in the present day has discarded this simple and perishable ornament, the leaves of the carrot are even now sometimes used as house decorations. If in the winter a section be cut from the end or thick part of the root, and this be placed in a shallow vessel containing water, young and delicate leaves are developed, forming a "radiated tuft," the graceful and verdant appearance of which make it a pleasing ornament for the mantel-piece in that season when any semblance of vegetation is a welcome relief to the eye.

The carrot is a biennial plant, the first year develops the root and stem, and the second year the flowers appear in the form of a close umbel, in June and July, and are succeeded by the seeds, which are covered with a rough coat of hairs or bristles. There are not less than ten varieties enumerated of the carrot, characterised by size, shape, and the earliness or lateness of their growth. The early carrots are short, and of a paler colour; the late are larger, longer, and of a deeper red hue.

The red or large field carrot attains to a considerable growth; it is chiefly cultivated in fields as food for cattle, and in farmer's gardens as a material for colouring butter. The orange carrot, though not so productive, is generally the main crop in garden culture; the flavour of this is more delicate, and therefore it is in higher estimation as a culinary vegetable. There are, likewise, white, yellow, and purple varieties; these are not, however, in common cultivation. The horn-carrot has a shorter and smaller root than the long varieties; it is, therefore, a good crop for a shallow soil, and in such a situation is preferable to the larger kind; it has likewise the advantage of coming to maturity in a shorter period than the long, and is consequently found well adapted for the early and late crops.

When a carrot is cut transversely, it is found to consist of two parts of different colour and texture. These are the bark and the wood; the bark is of the darkest colour, and of the most pulpy consistence, and it is also the sweetest to the taste; the heart or wood, especially when the root has attained its full size, is more fibrous or stringy, and, if it be separated, it is bristled over with hard points or fibres that extend to the rootlets outside. Almost the whole crown of the root, or the part which sends up the leaves, is connected with the wood, and only the epidermis of the leaves and stem with the external portions of the root.

The skin or bark is found to be more nutritious than the central part, and consequently the value of the carrot as an esculent will depend on the relative proportion of these two parts of the root. The object of the skilful cultivator is, therefore, to obtain the root with the smallest possible proportionate quantity of wood. In endeavouring to secure this result, much must of course depend upon the nature of the plants from which the seeds are obtained; but adaptation of soil is likewise a very important consideration.

The carrot is most successfully cultivated in a light mellow soil mixed with sand: the ground should be well dug to some depth, and made extremely friable and porous, that the roots may meet with no obstruction in running down, which would cause them to grow forked, and to shoot out lateral branches. This accident will happen, especially when the ground has been too highly manured previously to the seed being sown. It may perhaps be taken as a general rule that strong soils are not well adapted for any plants which form esculent roots deep under the surface, as the mechanical resistance which is thereby opposed to the swelling of the bulb forces much of the strength of the plant up into leaves; and in the carrot especially, that part of the root which is the most valuable is diminished in the greatest proportion.

The best mode of cultivating these roots has been made by many agriculturists a subject of inquiry. So early as the year 1765, this branch

of husbandry engaged the attention of the Society for the Encouragement of Arts, &c.; and, in consequence, an account of the culture of carrots, and the uses to which they may be applied, was published by Robert Biling, a farmer of Norfolk, in whose work much useful matter on the subject is obtained.

The seeds of carrots are surrounded by numerous forked hairs, by which they adhere to each other so tenaciously, that there is some difficulty in causing their separation; this is performed either by rubbing them through the hands, or by passing them through a fine chaff-sieve; but the best and most effectual method, as recommended by an intelligent cultivator, is to mix them with fine sand in the proportion of one bushel to every four or five pounds of seeds; this mixture is then laid in heaps, being occasionally watered and turned during two or three weeks previous to sowing. The above preliminary process not only occasions the more equal diffusion of the seeds, but likewise promotes their quicker germination; besides this, when they are sown alone their extreme levity causes great inconvenience, and prevents this operation from being successfully performed except in the calmest weather. The ground being duly manured, and reduced to the required degree of fineness, the seed mixed with the sand is sown about the middle of March or beginning of April: the seeds thus prepared germinate and send up young plants before the appearance of the annual weeds, which are always abundant in a soil so worked and manured. In about five or six weeks the plants are in a fit state for hoeing, and that operation two or three times repeated, according to the increase of the weeds, is all the after-culture which is requisite.

From this manner of sowing, more than eight hundred bushels per acre of carrots of very large growth have been obtained. According to Mr Arthur Young, the produce of these roots on indifferent land is about two hundred bushels, and on a more congenial soil six hundred and forty bushels per acre. The garden culture of carrots is somewhat different. In that case they are sown in a succession of crops from the latter end of February to the beginning of August, and the plants when hoed are thinned at regular distances, of from five to eight inches apart, the particular interval being regulated by the size of the variety under cultivation, and by the period of their growth at which they are to be drawn.

In order to preserve carrots for winter use, they are dug up in the beginning of November, and placed in a dry place in sand, by which means they may be kept without spoiling until March or April of the ensuing year.

To obtain carrot seed, some roots which have been taken up in November are replanted in February about two feet apart, and with the crown or head a few inches below the surface. Leaves and flower-stalks will spring up from these, and seeds will be produced which ripen in autumn. A considerable quantity of carrot seed is raised at Weathersfield in Essex, but this is insufficient for a home supply, and it is said much is imported from Holland into this country. It would appear that the production of carrot seed may occasionally be made a source of considerable profit to the cultivator. We find it recorded that, in the latter half of the last century, a farmer in Essex obtained from an acre of land sown with carrots ten cwt. of seed, which he sold in London for £10 per cwt. This is a very rare case. If it were general the price would soon be reduced.

The size of carrots differs, of course, very much according to soil, culture, and variety. Some have been known to measure two feet in length, and from twelve to fourteen inches in circumference at the thickest part. In the autumn of 1826 several were taken up in the neighbourhood of Lancaster, having an average weight of four pounds each; these were fine firm roots, and in every respect good for the table.

Carrots are very liable to the attacks of grubs and insects. These animals, especially some species of ring-worms, *(Iulus)* eat into the root, where they lie concealed, and thus cause what is commonly called canker. The upper part of the root is also attacked by the grub of a kind of fly; under these attacks the root and whole plant withers. The best remedy is late sowing, to avoid the period at which these insects are evolved from the eggs.

The carrot is extensively used in cookery, entering into soups and stews, as well as forming a vegetable dish. Besides their use as human food, carrots are in some places grown largely for the consumption of stock, especially for horses. It is affirmed that cattle which have once tasted these, usually prefer them so much to turnips, as with difficulty to be made to return to the latter. The milk of cows fed on carrots never acquires any unpleasant flavour, while at the same time the quantity produced is increased. Calves thrive admirably, and bullocks are quickly fattened on this food. Carrots are equally beneficial as nourishment for sheep, and are devoured with avidity by swine. In the short space of ten days a lean hog was fattened by these roots, having consumed during that period 196 pounds. Its fat proved very fine, white, and firm, and did not waste in the dressing. Horses receiving no other sustenance perform their work as usual without any diminution of their sleekness. The efficacy of these roots in preserving and restoring the wind of horses had, it is said, been partially known in Suffolk, where carrots were administered as a secret specific for the complaint,

long previously to their being commonly applied as food for horses. These roots may also with advantage be given to poultry. In severe winters they have been found of great utility in the preservation of deer; and they have been also strongly recommended as wholesome and cheap nourishment for dogs. Although, perhaps, the virtues and nutritive qualities of the carrot may be somewhat over-rated by writers who have evidently a strong bias in its favour, it is more than probable that carrots are a more wholesome food than either cabbages or turnips, as they are so strongly opposed to putrefaction, as to be occasionally used, on account of this property, in certain surgical applications. Various opinions exist among agriculturists as to the relative advantages arising from the culture of the carrot or the turnip as food for cattle. The latter root may perhaps be more productive, and succeed better in a variety of soils, but the positive amount of nourishment it contains would seem to be much less than that of the carrot. This assertion is advanced on the testimony of Mr Biling, who obtained from twenty and a half acres of land, varying in soil and degree of preparation, five hundred and ten loads of carrots. Experience led him to conclude that these were equal in use and effect to one thousand loads of turnips, and to three hundred loads of hay. At Parlington in Yorkshire, the stock of a farm, consisting of twenty working-horses, four bullocks, and six milch cows, were fed from the end of September to the beginning of May on the carrots produced from three acres of land. The animals, during the whole of that period, lived on these roots with the addition of only a very small quantity of hay, and thirty hogs were fattened on the refuse left by the cattle.

The greater part of the alimentary portion of the carrot consists, according to Sir Humphrey Davy's analysis, of saccharine matter, which may in a considerable degree account for its antiseptic qualities. The quantity of nutritive matter is nearly ten per cent. in the whole weight of carrot, being 98 parts in 1000, and of these three are starch or mucilage, and the remaining ninety-five saccharine matter. The quantity of ready formed saccharine matter in carrots is much greater than in any of the cerealia, being 2½ per cent. more than in barley, and about six times more than the quantity contained in potatoes. It is presumed, therefore, that carrots are much better adapted than the latter for the distillery. Dr Hunter, in the Georgical Essays, details experiments made to prepare from carrots a beverage resembling beer, and subsequently a spirituous liquor; the former proved unsuccessful; but the result of the latter was, according to the Doctor's opinion, very encouraging. "From a gross calculation," he concludes, "I am induced to think that a good acre of carrots manufactured in this manner will leave a profit of forty pounds, after deducting the landlord's rent, the cost of cultivation, distillation, and other incidental expenses. In this calculation I presume that the spirit is worth six shillings per gallon, and not excised." This is perhaps rather an exaggerated statement: it has, however, been found by other experiments that eighteen tons, the produce of one acre, will yield one hundred gallons of proof spirit, a larger product than that obtained from an acre of barley; while the refuse supplies a greater quantity of food for hogs.

Attempts have likewise been made to prepare sugar from carrots, but without success; a thick syrupy matter which refuses to crystallize can alone be obtained.

The Parsnip, *(pastinaca sativa.)* This is also a British plant, and grows wild in calcareous soils by road sides. The leaves are broader and less divided than those of the carrot; in the wild kind they are hairy, and dark green; in the cultivated parsnip smooth, and of a light yellowish green. The flowers have a yellowish tinge. The roots of the wild parsnip are smaller, tougher, and have less of the peculiar taste than the cultivated kind. *Pastinaca*, from *pastus*, nourishment, is one of the names given by the Romans to the *daucus* of the Greeks.

The parsnip has long been cultivated in English gardens. There are a great many varieties of this root, one only of which is cultivated in Britain. In France, as well as in Guernsey and Jersey, where the soil is peculiarly adapted to this cultivation, three varieties are distinguished by the names of *coquaine*, *lisbonaise*, and *siam*. The first runs very long, to the depth of three, and even four feet in the ground, and attaining to from three to four inches in diameter; while its leaves grow proportionally high, and proceed from the whole crown of the root. The *lisbonaise* is shorter, but considerably thicker, and of an equally good quality; the leaves of this variety are small and short, and proceed only from the centre of the crown. The *siam* has not so large a root, and is of a slightly yellow tinge; it is more tender, and of a richer flavour than the other varieties.

A light, deep soil, free from stones, is requisite for the favourable growth of the parsnip. The seed is usually sown at the latter end of February or March, in the proportion of nearly three and a half pounds of seed to one rood of land. It is sown broad-cast, and raked into the ground. The only after-culture required is to keep the plants free from weeds, and to thin them to about a foot distance from each other. The roots come to maturity at the latter end of October; this state is indicated by the decay of the leaf; they are then fit for use.

The parsnip is not so liable as the carrot to be hurt by frost. Indeed, by many, the root is not

esteemed till it has had a touch of the winter cold. Part of the crop may be dug up and covered with sand for use in November, while the rest will keep good in the ground till they begin to shoot in the spring, when they may be dug up in February or March, the tops cut off and preserved in sand till the end of April. To obtain the seed, transplant some of the best roots in February two feet asunder, inserted over the crowns. They will shoot up in strong stalks, and produce large umbels of seed ripening in autumn.

When the parsnip is grown upon poor land it loses much of the rank taste which it acquires if cultivated in richer soils, and though not nearly so abundant, is far more sweet and agreeable. Thus produced, when slowly roasted in the ashes of peat or turf, it becomes nearly as farinaceous as the best potatoes, and in some of the poorer districts of the country is used with the same additions as an article of substantive food. "In the north of Scotland," Neill observes, "parsnips are often beat up with potatoes and a little butter; of this excellent mess the children of the peasantry are very fond, and they do not fail to thrive upon it." From the same authority we learn that in the north of Ireland an agreeable beverage is prepared from the roots brewed with hops. In some places a species of wine is also made from them, and a very pure spirit is obtained when parsnips are distilled after a similar preparatory process to that used with the carrot. In Catholic countries the parsnip is more abundantly employed for human food than in Britain. It was, however, formerly held in much greater estimation here than it is at present. This root is wholesome as well as hardy, but, as the soil which is most favourable to its production as human food, is also best adapted for the growth of the potato, which is both more productive and more nutritious than the parsnip, the culture of this plant as a culinary esculent, has declined; and the use of it with salt fish in Lent may perhaps be regarded more as the relic of an old custom than as a choice arising from any partiality for the peculiar flavour of the parsnip in combination with this particular kind of viand.

According to Arthur Young, about the time of the revolution, half the people about Marlaise in France, subsisted on parsnips, during winter, boiled in soup and various other ways. They also feed horses with them, and for this purpose they are accounted as nourishing as oats.

The nutritious matter in parsnips is found by analysis to be ninety-nine parts in a thousand, of which nine parts are mucilage, and the remaining ninety are saccharine matter.

The Skirret, *(sium sisarum.)* This is a perennial tap-rooted plant, a native of China, and introduced into this country about the year 1548. It is of more diminutive size than either the carrot or parsnip. It has pinnated leaves,

116.

Skirret.

and a stem twelve inches high, terminated by an umbel of white flowers. The root consists of a cluster of tubers about the size of the little finger; at first they are small fibres, but swell out gradually to this size. They are connected together at the crown or head, and covered with a whitish rough bark, with a hard cone or pith running through the centre. They contain a mucilaginous and saccharine matter, and were at one time much esteemed in cookery. The skirret is propagated either by seeds or offsets from the root. Those raised from seed are the most tender. The skirret is one of those plants which are now neglected, because we are become acquainted with others more pleasant to the taste, and more profitable in their culture. Its peculiar sweetness, so delightful to the palates of our less refined forefathers, to us appears nauseous lusciousness; and that root which the emperor Tiberius esteemed so much as to cause it to be brought from the banks of the Rhine for the use of his table, is little relished in the present day. Beckmann ingeniously accounts for this change of taste in the use of vegetable productions. "In the oldest times mankind were so fond of sweet things, that the goodness and agreeable taste of every kind of food was determined according to the degree of its sweetness; and such is the manner of judging, even at present, throughout all the East, in Africa, and in America. This is the case also among us with the greater part of the lower classes, who are not able to follow the mode of richer tables. In the northern countries this taste is almost every where prevalent. Thus the Swedes spoil, by the addition of sugar, costly Rhenish wines, sauerkraut, and other articles, the agreeable tartness of which is gratifying to other nations. In proportion to their population and luxury, the Swedes seem to use more sugar than the Germans, and the Germans more than the English

or French; and one might almost suspect that a taste for sweet things was in the inverse ratio of culture. At any rate, one can thus explain why many vegetable productions which some centuries ago were reckoned among the most agreeable dishes appear to us to be nauseously sweet."

For some time after the cultivation of skirrets had become neglected in the gardens of the rich, they still continued to be an object of culture among the poor in a few remote parts of the country. But even in those situations they have now very generally given way to the potato, and are seldom grown, and even then rather from the love of variety than for any superior properties they may possess. In the north of Scotland this plant was cultivated under the name of crummack.

Silver Weed, *(potentilla anserina.)* A creeping plant belonging to the natural family Rosaceæ, and very common by waysides, and in waste places; known also under the name of goose-grass. The leaves are interruptedly and deeply pinnate, of a silvery shining aspect. The flower is a pretty yellow. The roots are oblong, and sometimes attain a considerable size. These are amylaceous when roasted or boiled, and resemble in taste the chestnut. In spring, when the fields were ploughed up, these used to be gathered by the inhabitants of many parts of Scotland, and eaten either raw or roasted. It is not improbable but cultivation might increase these roots to a considerable size. The plant is hardy, and extremely prolific, as it spreads by runners as well as by seeds.

Celery *(apium graveolens)*. This is a hardy biennial plant, a native of Britain, and known in its wild state by the name of *smallage*. It is frequent by the sides of ditches and near the sea, where it rises with wedge-shaped leaves and a furrowed stalk, producing greenish flowers in August. The whole plant has a rank coarse taste; and the effects of cultivation, in producing from it the mild sweet stalks of celery, are not a little remarkable. In its cultivated state it sometimes attains an immense size. A head of celery was dug up in 1815, in the neighbourhood of Manchester, which weighed nine lbs. when washed, with the roots and leaves all attached to it, and measured ten feet six inches in height. It was of a red sort, perfectly solid, crisp, firm, and remarkably well flavoured.* The blanched leaf stalks are used raw as a salad from August till March, and are also stewed in soups and other dishes.

There are several varieties of the cultivated celery, such as the early, red, and white solid, North's upright, the turnip-rooted, or celeriac. The red variety is of a coarse but more hardy nature than the others; and though not so delicate as salad, is well suited for stews and soups. The Italians use the green leaves and stems in their soups, and, as a matter of economy, these impart an agreeable enough flavour to soups; the seeds also are used in a similar manner. The celeriac, or turnip-rooted, is a hardy kind. The root is the only part used. It attains to a very considerable size, especially in Germany, where it is much esteemed, either as entering into the composition of mixed dishes, or prepared by itself. For this purpose it is divested of the external skin and fibres. The boiled root sliced when cold, and mixed with oil and vinegar, is considered a very choice salad. Celeriac is occasionally imported from Hamburgh into Britain; but it is not generally cultivated in our gardens. According to Mr Ellis, it is easier cultivated than the other kinds, and requires less space. The knob-roots, however, have a constant tendency to degenerate, or return to the natural type.

The best soil for celery is a rich deep vegetable mould. The seed is sown in spring, and if wished to be early, may be forced in a hot-bed. When the plants are from two to four inches high, the seed-bed is thinned, and those removed are transplanted from them to six inches apart from each other, in an intermediate bed. They remain in this situation till they become vigorous plants, of from six to twelve inches high; they are then finally transplanted, and generally into trenches. The plants are placed at from five to ten inches apart, and as they grow up the stems are gradually covered up with earth. This operation being repeated every fortnight, till at length they are covered to one, and even to two feet high, in order that they may be blanched, and thus a considerable portion be made edible. By this management celery is obtained from August to March; and when the soil is favourable and the cultivation skilful, these plants attain to a very large size.

Parsley *(apium petroselinum)*, was known to the Greeks, and received its distinctive name of *petroselinum* from Dioscorides. It is said to be a native of Sardinia, whence it was brought into England about the middle of the sixteenth century; but the plant is of so ancient culture in this country, that the period of its introduction cannot, perhaps, be accurately assigned, and though supposed not to be indigenous to Britain, it is now completely naturalized in various parts both of England and Scotland. It is a hardy biennial plant.

The principal varieties are the common plain-leaved, the curled-leaved, and the Hamburgh, or broad-leaved. The plain-leaved parsley was the first known in this country; but it is not now much cultivated, since the leaves are not so handsome as those of the curled, are of a less brilliant green, and are coarser in flavour. Another reason for banishing it from the gardens is its re-

* Loudon.

semblance to fool's-parsley, or lesser hemlock, *Æthusa cynapium*, which is a noxious weed of a poisonous nature, infesting gardens and fields. If this intruder were growing among plain parsley, an unobservant person might confound the leaves of the one with the other, although they differ somewhat in shape and colour; the leaves of the poisonous plant being of rather a darker green, and, if bruised, they emit an unpleasant odour, very different from that of parsley. When in flower they are easily distinguished, the *æthusa* having an involucrum of three long, narrow, sharp-pointed leaflets, hanging down under every partial umbel, and vulgarly termed the *beard;* while in the garden-parsley there is usually only one leaflet at the general umbel, and at the partial umbel the involucrum consists of only a few short folioles, almost as fine as hairs.

Parsley is raised from seed, which is sown in the early part of spring, most generally in single drills, round the edges of any of the vegetable beds. The plants appear in three or four weeks, and soon the tender leaves are fit to be gathered for use; a succession springing forth and furnishing a supply throughout the whole of the year, till the ensuing May, when the flower-stalks begin to run, bloom, and bear seed in July or August.

The Hamburgh parsley is cultivated for its roots. For this purpose a deep well dug soil is requisite. The seed is to be sown in February, March, or early in April. The plants should be thinned to nine inches distance, to give room for proper growth in the roots. These will be fit for use in autumn, and will continue good till spring. These roots are similar to, and are used the same as parsnips.

Parsley has been supposed to be an effectual cure for the rot in sheep, provided it be given to them in sufficient quantities. Attempts were made some years ago to promote its extensive culture in fields for this purpose, under the auspices of the Society for the Encouragement of Arts, &c. It is said that this specific was tried in Hampshire with success; and Mortimer mentions the cultivation of parsley, as a remedy against this destructive disease, being practised in Buckinghamshire. This herb, when used as food for sheep, imparts to their flesh, it is said, a very agreeable flavour.

Hares and rabbits, we are told, will come from a great distance in order to indulge their taste for parsley; and in countries where these animals abound, in no situation does their favourite herb escape from their depredations unless securely fenced.

Fennel *(anethum fœniculum)*, is a plant of very ancient use, and if not native, is at least naturalized in England, where it is sometimes found growing on chalky soils. It is a perennial, rising to the height of five or six feet. The leaves are divided into a variety of fine long segments, of a bright green colour. Yellow flowers, growing in umbels, appear in July and August. The whole plant has a strong and disagreeable odour. Its light and delicately formed leaves are occasionally used as a garnish; and, when boiled, enter into the composition of certain fish-sauces.

Caraway *(carum carui)*. The caraway is a biennial aromatic plant, a native of England, and still found growing wild occasionally in meadows and pastures. This plant is cultivated for its seeds chiefly, which are of a pleasing aromatic flavour, and are used in confectionary and sometimes in medicine. In spring the under leaves are occasionally used in soups; and in former times the fusiform roots were eaten as parsnips, to which root Parkinson gives them the preference. In Essex large quantities of the seed are annually raised for distillation with spirituous liquors. Its culture is easy; the seeds are sown in autumn, they soon vegetate, and the crop is to be weeded and thinned, one plant being sufficient to the square foot. Next season the plants run into flower and seed; when the latter is ripe, the plants are pulled up by the root, and put into a dry place till the seeds are fully matured.

Dill *(anethum graveolens)*. Dill is a hardy biennial plant, a native of Spain, and introduced into Britain in 1590. The plant grows upright, and resembles fennel, only is smaller. It has a slender single stem, and leaves finely divided, or pinnatifid. The flowers, which form an umbel, appear in June or July. The whole plant is strongly aromatic. The leaves are used in certain pickles, as cucumber, and to give flavour to soups and sauces. It is also occasionally used in medicine. It is easily raised from seed, which should be sown in February, March, or April, or in autumn.

Chervil *(scandix cerefolium)*. This is an annual plant, indigenous to various parts of Europe, and sometimes observed naturalized in English gardens. It rises to nearly two feet in height; the leaves are of a very delicate texture, three times divided; and the flowers, which are of a whitish colour, appear in June. The tender leaves are used in soups and salads, and those of a curled variety, common in France, in garnishing. It is easily raised from seed, the sowing of which may be commenced in February, and continued every month for a succession of young plants.

Sea Holly *(eryngium maritimum)*. This is a plant which grows wild in Britain, belonging to a family of singular plants, somewhat like thistles in general aspect. They are usually of a bluish hue, prickly, and with large involucres, and dry horny leaves. Linnæus says that the tops of sea holly are eaten like asparagus in Sweden. The roots of this plant have been celebrated

since the time of Dioscorides as a medicine, and are said by him to be a specific for flatulence. The roots formerly used to be candied, and sold in the shops under the name of kissing comfits. They are thus alluded to by Shakespeare. They are reckoned stimulating and restorative; but have fallen entirely into disuse in modern practice.

CHAP. XXXII.

THE CRUCIFERÆ, INCLUDING THE TURNIP, MUSTARD, CABBAGE, RADISH, CRESS, &c.

The natural family of *cruciferæ* is a well marked one, and contains many plants of considerable importance to man. The cross-like form which the four petals of the corolla assume in all the species, has afforded the general name of the family. The order consists wholly of annual or perennial, often of biennial herbs, occasionally assuming a half shrubby form, but even in this case, not exceeding the height of three feet. The roots are either thick and perennial, or annual or biennial, and slender, almost always perpendicular, and undivided. The young roots are tipped with a little sheath called the coleorhiza, which is produced by the extended ruptured coat of the epidermis when the rootlet first appears. The stems are round or somewhat angular, branched, and often even in the annual species indurated at the base. The branches proceed from the axilla of the leaves, but the uppermost ones are in most cases abortive. The racemes are always opposite to the leaves. The leaves are simple, generally radical, or alternate, or rarely opposite. The flowers are either white, yellow, or purple; or in a few Cape species bright blue. The fruit is called either a siliqua or silicula; the former being a linear pod containing many seeds, the latter a roundish pod containing one or very few seeds.

The whole order is pre-eminently European: 166 species are found in the north and middle of Europe, and 178 on the sea shores of the Mediterranean; 45 are found between Mogadore and Alexandria; 184 in the countries of the east, as Syria, Asia Minor, Tauria, and Persia; 99 in Siberia; 35 in China, Japan, and India; 16 in New Holland, and the South sea islands; 6 in the Mauritius and adjacent countries; 70 at the Cape, 9 in the Canaries, 2 in St Helena, 2 in the West Indies, 41 in South America, 48 in North America, 5 in Kamchatka and the bordering islands; and finally, 35 are common to several parts of the globe. From this it appears that there are about 100 species in the southern hemisphere, and about 800 in the northern; or, if they are considered with reference to the zones of temperature, 205 are natives of the frigid zone of the northern hemisphere; 30 of the whole of the tropics, 548 of the temperate zone of the northern hemisphere, and 86 of the southern. The forty-first degree of north latitude may be considered the equatorial line of this family, about half being found on one side of it, and half on the other. Their station is very variable; many inhabit open sandy plains, some form the vegetation about the limits of the perpetual snows of lofty mountains, and many follow the footsteps of man through all parts of the world.

The useful qualities of the turnip, the radish, the rape, and the cabbage, with its multiform varieties, are all well known. The greater part of this order consists of plants possessing high antiscorbutic powers. These appear to depend upon a certain acrid, volatile, oily principle, the chemical nature of which is imperfectly known. It is particularly abundant in the seeds of mustard, and the roots of horse radish; and the leaves of a pepper wort, *lepedium latifolium*, which latter exercises a violent influence upon the organs of digestion. The same sort of acrimony, but in less degree, is found in the herbage of the scurvy grass; and the roots of the radish, which act much more mildly when taken inwardly. Thus, when any cruciferous plants are found to be eatable, either from culture or other circumstances, it is to be understood to depend upon a reduction of this acrid principle. The exciting powers of this last are what renders the horse radish, the scurvy grass, and others, so remarkably useful as antiscorbutics; they are also believed to possess diuretic and diaphoretic qualities. It is to be remarked that, cruciferæ are always eatable when their texture is succulent and watery, as in the roots of the radish, and the turnip, and the leaves of the cabbage tribe. A further diminution of the acrid principle is produced by blanching; cruciferæ are said to possess a greater share of azote than any other tribe of plants, as is apparent in their fœtid smell when fermented. The embryo of all the order abounds in oil, whence several species are employed with much advantage for expressing this fluid, either for eating or for the purpose of burning. Some of the species are extremely beautiful and fragrant, as the stocks, the gillyflowers, the hesperides, the candy tufts, and many others. The Hutchinsias, drabas, cardamins, are among the most interesting of alpine plants.

This natural order includes the whole of Linnæus' 15th class, *Tetradynamia*, and a single other genus, Cleome.

The Turnip, *(brassica rapa.)* This we put at the head of the cruciferæ, as being one of the most important species of the family. The turnip is a biennial plant, indigenous to Britain. If the cultivated plant be in reality a variety of

this, of which there is some doubt, its nature has been greatly changed by the labours of man. In the first year the turnip produces the large radicle leaves, and the well known root. In the second year a stem shoots up crowned with numerous four-petalled flowers in the form of a cross, containing six stamens. The seeds are contained in an elongated pod.

The turnip, if it was not familiar to the Greeks, was well known to the Romans, and all that can be gathered on this subject from the writings of the ancients renders it probable that it occupied nearly the same place in Roman culture as it does in British husbandry in the present day. Columella recommended that the growth of turnips should be abundant, because those which were not required for human food could be given with much advantage to cattle; and both Pliny and he concur in their testimony, that this produce was esteemed next to corn in utility and value. The best grew in the country of the Sabines, and were worth at Rome a sestertius or twopence each.

It is averred that the Roman method of cultivation must have been superior to that of the moderns, since Pliny relates that some single roots weighed as much as forty pounds, a weight far surpassing any which has been obtained by the most skilful modern agriculturists. Indeed, the large size of the Roman turnip is supposed by some authors to furnish a collateral proof of the colder temperature of Italy in ancient than in modern times. Speculations, however, raised upon what might perhaps have been an exaggerated statement of the Roman naturalist, must be purely hypothetical. It is certainly found by experience that a warm climate is not so favourable to the growth of the turnip as cold moist regions. Though receiving equally careful culture, it does not attain to the same size in the south as in the north of England and in Scotland, while it thrives best in the west of the latter country, and in those parts of Ireland where the climate is the most humid. Though the colder parts of the temperate regions are found most favourable for this cultivation, the countries of still higher latitudes are not congenial to the growth of the turnip. Those arctic climes where the summer, though brief, is dry and warm, are decidedly adverse to its successful cultivation.

It is very probable that the garden culture of the turnip was introduced by the Romans into this country, and that, like some of the fruit-trees which they had transplanted here, though neglected, it was never altogether lost; and, if appearing to be so for a time, was restored by the monks, those constant guardians and fosterers of horticulture.

There is no doubt that this root was in cultivation in the sixteenth century. Whether revived by native industry, or introduced at that period by the Flemings, is a question differently answered by different writers; nor does the inquiry possess much interest. Turnips were partially grown for many years in this country, before they came into extensive notice. Horticultural pursuits were at that time so little understood and practised here, that even the most successful issue which attended the cultivation of the turnip in Norfolk, a county peculiarly adapted to its growth, failed for a long time to be followed by its more extended adoption; and a considerable period elapsed before it travelled out of Norfolk into Suffolk, and thence into Essex.

Towards the latter end of the sixteenth century it is mentioned by more than one writer. Cogan, in his Haven of Health, published in 1597, says, that "although many men love to eat turnips, yet do swine abhor them." Gerarde, who published in the same year, and who had rather more rational views on the subject of plants, leads us to conclude that more than one variety was cultivated in the environs of London at that time. "The small turnip," says he, "grown by a village near London, called Hackney, in a sandie ground, and brought to the crosse in Cheapside by the women of that village to be solde, are the best that I ever tasted." Gerarde is silent concerning the field culture of turnips; neither is this mentioned by Parkinson, who wrote in 1629. It is not until the close of the seventeenth century that we can find any account of this root being thus cultivated in any part of the country.

The turnip, in some of its varieties, is of very universal culture throughout Europe. In Sweden it is a very favourite vegetable. We also learn from the interesting journal of Linnæus, that even so far north as Lapmark the colonists sow annually a considerable quantity of turnip seed, which frequently succeeds very well, and produces a plentiful crop. The native Laplanders are so fond of this root that they are often induced to part with a whole cheese in exchange for one single turnip, "than which nothing," our author adds, "can be more foolish."

In Russia, turnips are used as fruit and eaten with avidity by all classes. In the houses of the nobility, the raw turnip cut in slices is handed about on a silver salver, with brandy, as a provocative to the more substantial meal. "The first nobleman of the empire," says Dr Clark, "when dismissed by his sovereign from attendance upon his person, may be found throughout the day with his neck bare, his beard lengthened, his body wrapped in a sheep's skin, eating raw turnips, and drinking quass."

It is said that the roots of the turnip cultivated in the plains of Germany seldom exceed half a pound in weight; and that in France and counties still farther to the south, they are yet more

diminutive. These are, however, no doubt a particular species naturally of a small growth, and it must not thence be inferred that hot countries are wholly inimical to this production. At Benares, in Hindostan, a latitude of about 26°, turnips, radishes, asparagus, cauliflowers, and other garden vegetables are raised in considerable plenty by the natives, and exposed to sale in the bazaars, principally for European purchasers, to whom these plants of home association are welcome even among the rich display of tropical productions, and even though they cannot be obtained in their native excellence, being comparatively tasteless when raised under the fervid sun of India. When destined for human food, of course the quality more than the size of this root is considered; but in raising them as an economic aliment for cattle, the greatest possible quantity of nourishment which can be produced in a given space is the object most to be desired. Various sorts, differing in size, shape, and colour, but all assuming, in a greater or less degree, the globular or spheroidal form, are the objects of either garden or field culture. Of these there are ten varieties in common cultivation, distinguished by colour, size, time of coming to maturity, productiveness, or flavour. Among this number, the Maltese golden turnip is a very fine variety, of one uniform orange tinge. It is perfectly spherical, and the crown and tap-root are both so very small, that if dexterously removed the exact parts of the root whence they were divided are not easily discernible. When quite fresh, and just before it has acquired its full consistence, it makes its appearance in the northern parts of the country with the dessert, and it is considered to be superior both in form and flavour to many fruits. The Swedish turnip is another variety of a much larger growth, and of a more hardy nature than any of the other kinds under cultivation; this is very seldom raised among garden vegetables, as it is too strong and harsh to be acceptable for human food. It has, however, the advantage of surviving through seasons when even the hardiest of the others would be destroyed. This turnip is largely cultivated in fields and employed as food for cattle.

The root of the French turnip, or *naveu*, differs from the other varieties, having more the appearance, in shape and size, of the carrot. It is of a very fine flavour, and in high repute on the Continent. When used, the outer rind is not peeled off as in the common turnip, but merely scraped, since the peculiar taste chiefly resides in that part. In France, as well as in Germany, few great dinners are set on the table without this vegetable appearing under some form, either enriching the gravies and stews, or prepared as a viand by itself. The naveu was more cultivated in this country a century ago than it is at present, being now but rarely found in our gardens.

In Barbary a small parsnip-like turnip with fibrous roots, called in that country *el bash ouro*, is held in much esteem for its agreeable pungency.

A light gravelly soil, broken fine by tillage, is most favourable to the production of turnips of the best quality; but they will succeed in almost any land. Any poor, light, sandy ground suits the naveu, which has the great advantage of never requiring any manure in its cultivation.

Turnips may be obtained in this country in succession almost throughout the year by sowing seed every month in spring and summer. This is distributed broad-cast, or sometimes sown in drills in the proportion of about half an ounce of seed to one hundred square feet. As soon as the plants are sufficiently advanced, having rough leaves of about an inch broad, they are hoed and thinned to six or eight inches apart from each other. In the early stages of their growth turnips are rather a delicate crop. When they first put forth their tender and succulent seed-leaves, they are liable to be preyed upon by a peculiar species of beetle called thence the turnip fly; this is extremely destructive, and various preventives against the evil have been suggested. Several preparations of the seeds previously to sowing have by turns been recommended, such as steeping them in sulphur-water or sprinkling them with soot at the time of sowing; these, however, have not been considered efficacious, and even when they have apparently been successful, perhaps it has been under circumstances in which the plants would have equally escaped without any precautionary measure. No insect can very well deposit its eggs in the seed of the turnip before it is in the ground, at least there is no known species which perforates the pods for that purpose. The sulphur or soot, or any other application, is of course thrown off with the tunic or outer coat, and does not in any way protect the cotyledon or side lobes of the seed, which come up in the form of leaves, and in which the eggs of the fly are then deposited. By some cultivators these leaves are powdered with quick-lime as soon as they show themselves above ground; a plan which appears the most rational for preventing the mischief. One of the easiest remedies against it, however, is recommended by Neil, to sow thick, and thus ensure a sufficiency of plants both for the fly and the crop. As soon as the rough leaves are a little developed, the danger from the insect depredator ceases.

Loudon says, as to the choice of seed, it should be bright and well dried. In seasons when the turnip fly is dreaded, old seed may be mixed in equal parts with new, the mixture divided, and one half steeped twenty-four hours in water. By this means four different times of vegetation are

procured, and as many chances of escaping the fly.

Turnips, if carefully cultivated, attain to a very great size in this country, though appearing insignificant when compared with the gigantic root of the Roman naturalist. Tull speaks of some weighing as much as nineteen pounds, and of often meeting with others of sixteen pounds. In Surrey, a Swedish turnip, the seed of which had been sown in July, was dug up in October, 1828, which weighed twenty-one pounds, and was one yard in circumference. But these are far surpassed by one which was pulled up in 1758 at Tudenham, in Norfolk, and which weighed twenty-nine pounds. In No. 360 of the Philosophical Transactions, we find a curious calculation made by Dr Desaguliers, on the rapid increase of a turnip root. One ounce of turnip seed was found by him to contain between fourteen and fifteen thousand single seeds; therefore, one seed would weigh one-fourteen or one fifteen-thousandth part of an ounce; and assuming its growth to be always uniform, a turnip seed may increase fifteen times its own weight in a minute! By an actual experiment made on moss or peat ground, turnips have been found to increase by growth 15,990 times the weight of their seeds each day they stood upon it. It is not, however, only the size and weight of the root which renders this crop so productive; the number contained in a given space, with reference to their size, is very great. Some writers speak rather marvellously on this subject, but it is generally thought a good crop to obtain a turnip from each square foot of ground. Mill considers an average crop to be 11,664 roots per acre, which at six pounds each, will be 69,984 pounds.

The uses of the turnip as a culinary vegetable, are too familiarly known to require that they should be here enumerated. Though in very extensive favour among the moderns, the different modes of preparing it appear poor and insipid compared with those efforts of gastronomic skill by which the ancients made it assume so many inviting forms. It is related that "the king of Bithynia, in some expedition against the Scythians in the winter, and at a great distance from the sea, had a violent longing for a small fish called *aphy*—a pilchard, a herring, or an anchovy. His cook cut a turnip to the perfect imitation of its shape; then, fried in oil, salted, and well powdered with the grains of a dozen black poppies, his majesty's taste was so exquisitely deceived, that he praised the root to his guest as an excellent fish. This transmutation of vegetables into meat or fish, is a province of the culinary art which we appear to have lost; yet these are *cibi innocentes*, (harmless food) compared with the things themselves."

Our more immediate ancestors appear to have applied the turnip to more extensive uses as an esculent than is done in the present day. It is recorded, that in the years 1629 and 1630, when there was a dearth in England, very good, white, lasting, and wholesome bread was made of boiled turnips, deprived of their moisture by pressure, and then kneaded with an equal quantity of wheaten flour, the whole forming what was called turnip-bread. The scarcity of corn in 1693, obliged the poor people of Essex again to have recourse to this species of food. This bread could not, it is said, be distinguished by the eye from a wheaten loaf; neither did the smell much betray it, especially when cold.

The earliest spring-produced leaves of the turnip are sometimes boiled or stewed, and appear on the table under the name of turnip-tops. The Romans likewise applied these tender leaves to the same purpose.

Turnips, in all their varieties, do not contain so much nourishment as either carrots or parsnips. Sir Humphrey Davy's analysis gives only forty-two parts of nutritive matter in one thousand parts of the common turnip, and sixty-four parts in one thousand parts of the Swedish root; but as the turnips cultivated in the environs of London are not considered of so good a quality as those farther north, it is probable that this estimate may be somewhat below the average proportion.

The Cabbage Tribe, *(Brassica oleracea)*, is perhaps of all culinary vegetables, the most ancient as well as the most extensively cultivated. The original plant being extremely liable to run into all sorts of varieties, has in the course of time become the parent of a numerous race of culinary vegetables, so various in their habit and appearance, that to many it may appear not a little extravagant to refer them to the same origin. Besides the different sorts of white and red cabbage and savoys which form their leaves into a head, there are various sorts of borecoles which grow with their leaves loose, in the natural way, and there are several kinds of cauliflower and brocoli which form a head of their stalks or flower buds. All these, from the true cabbage, growing to the height of twelve feet, to the colzer and some other varieties, which before they come into bloom seldom exceed a foot in height, including the turnip rooted cabbage, and the Brussels sprouts, claim a common origin from the single species of Brassica above mentioned.

The principal varieties of this plant are :

1. *The White Cabbage, (Brassica oleracea capitata)*, with firm compact conical head, glaucous green externally, blanched within, from two to twelve and fifteen inches in diameter.

2. *Red Cabbage*, (B. O. *rubra)*, of similar form to the white, but of a purple or red colour.

3. *Savoy*, (B. O. *sabauda)*, with wrinkled leaves, either open or formed into a compact head; a winter vegetable.

4. *Brussels sprouts*, (B. O. *sabauda*), a sub-variety of the last noticed, with an elongated stem, four or five feet high from the alæ of the leaves of which sprout out small green heads, like cabbages in miniature.

5. *Borecole*, (B. O. *Sabellica*), with an open head of curled or wrinkled leaves, deep green, and very strong and hardy. Of this kind of the common kale, or *curlies*, there are a great many sub-varieties, no less than fourteen being enumerated. The most common and useful are the green, the dwarf, the purple or brown, and the German greens or curlies of Scotland.

6. *Cauliflower*, (B. O. *botrytis*), with the undeveloped flower buds, forming a close firm cluster or head; a late variety of this is the

7. *Brocoli*, (B. O. *botrytis*), a hardier plant than the other, and with more colour in the flower and leaves. The chief varieties are the green, purple and dwarf brocoli.

Several varieties of the cabbage have been cultivated from the very earliest times of which we have any record. But the migrations and changes of the best sorts have not been traced: neither is it at all probable that the varieties which the ancients enjoyed have descended to us unaltered.

It is probable that some species of the brassica were first introduced into this country by the Romans, since *kale* is mentioned among the oldest English records. It is well known that brassica was in very common cultivation at Rome, where, according to Columella, it was a favourite edible with freemen, and in sufficient plenty to be an article of food for slaves. The ancient Germans likewise cultivated this plant from very remote times; whether they, too, were indebted to their Roman conquerors for its introduction it is impossible to decide. The Saxon name for February is sprout-kale, and that is the season when the sprouts from the old stalks begin to be fit for use; the Saxons must therefore, of course, have been familiar with the culture of cabbage or kale, as it is not at all probable that they invented the name after their settlement in this country.

The variety of brassica which was first cultivated in England cannot be ascertained, since our ancestors had no distinctive name for the different kinds. Many improvements have been made in the cultivation of this vegetable, and many new varieties introduced by different individuals at comparatively recent dates.

The close-hearted variety, which is now more peculiarly called cabbage, was for many years imported into England from Holland. Sir Anthony Ashley first introduced its cultivation into this country, and made the English independent of their neighbours for a supply. This planter of cabbages likewise rendered his name known by other deeds, less creditable to his character. It is related that he had a command at Cales (Cadiz), where he got much by rapine, especially from a lady who intrusted her jewels to his honour; whence the jest on him, that he got more by *Cales* than by *cale* and cabbage. There is said to be a cabbage at his feet sculptured on his monument at Wimborne St Giles, in Dorsetshire. Although Sir Anthony Ashley introduced the cabbage, it does not appear to have become generally cultivated, for we continued to import the vegetable for many years. Ben Jonson, who wrote more than half a century afterwards, says "He hath news, from the Low Countries, in cabbages."

It is recorded that cabbages were first introduced into the north of Scotland by the soldiers of Cromwell. A country embroiled in internal hostilities might be supposed not to be in a very favourable state for the more extended cultivation of plants, the passions of the contending parties being too keenly roused to pay attention to improvements in those arts the progress of which more peculiarly belongs to a period of peace. But in the present case the fact is opposed to this conclusion; we learn that "Cromwell was a great promoter of agriculture and the useful branches of gardening, and that his soldiers introduced all the best improvements wherever they went."

The colonies of German fishermen from Cuxhaven and the adjacent places, which peopled the coasts of the central parts of the east of Scotland, are, however, supposed by some writers to have brought with them their national love of brassica, and to have introduced some species of those plants at a period much anterior to that of the Commonwealth, to this part of Scotland, which is more peculiarly "the land of kale." There the cabbage and the open colewort are in equal favour, giving the name of kale to a soup of which they form the principal ingredients, the outside leaves and the stalks of the plants falling to the share of the cattle.

Many allusions in the old Scotch songs point to the fact of the country about Aberdeen abounding with this vegetable. In recommending the good fare of the country, the poet says,

> "There's cauld *kail* in Aberdeen,
> An' *castocks* in Stra'bogie."

These castocks are the cabbage stems having the fibrous part peeled off, and the remainder softened by boiling. Before the introduction of the turnip into general use in Scotland, this medullary substance of the stalks of the brassica was very commonly eaten by the peasantry. The "kale brose o' auld Scotland" is celebrated to the same tune as the "roast beef of old England;" and though, with many of the ancient peculiarities of the people, it has fallen much into disuse, it is still considered a national dish.

The White and Red Cabbage. In these the leaves gather into what is called a head, and are blanched by their own compression. The green colour is always much more completely destroyed by this blanching than the red; and the smaller the tendency which the expanded leaves have to blue or purple, the more sweet and crisp will the head become.

Cabbages are propagated by seed, which is sown at the three seasons, spring, summer, and autumn, to obtain a supply in succession. The soil for the seed-beds should be light, and not very rich.

The plants, from seed sown in autumn, are finally transplanted in spring. Most generally the seedlings are pricked out from the seed-beds as soon as they have one or two leaves of an inch or two broad, into beds of good earth: thence they are transplanted into a rich soil, which should be well manured.

Kale or Colewort.—In these the leaves are expanded and coloured, with the exception of a small portion in the centre, which encloses the rudiments of the flowering stem. The plain-leaved colewort is now seldom found in English cultivation. Borecole, or curly-leaved colewort, *Brassica oleracea* var. *ꝺ sabellica*, very generally, however, finds a place in our gardens. The green borecole, or Scotch kale, and the purple or brown borecole, are the most hardy of the race, and are therefore best adapted for cold situations and late seasons. The plants, when vegetating in a rich soil, grow vigorously, and attain to large dimensions; but, in common with most of the genus, moderate sized plants are best for culinary purposes, the very large being harsh, and those which are so small as to be stunted are better.

Sauerkraut, "that excellent preparation" of the Germans, and of which they are so immoderately fond, is merely fermented cabbage. To prepare this, close-headed white cabbages are cut in shreds, and placed in a four-inch layer in a cask; this is strewed with salt, unground pepper, and a small quantity of salad oil: a man with clean wooden shoes then gets into the cask, and treads the whole together till it is well mixed and compact. Another layer is then added, which is again trod down, and so on until the cask is entirely filled. The whole is then subjected to heavy pressure, and allowed to ferment; when the fermentation has subsided, the barrels in which it is prepared are closed up, and it is preserved for use. The preparing of sauerkraut is considered of so much importance as to form a separate profession, which is principally engrossed by the Tyrolese. The operation of shredding the cabbage is now performed by a machine, which the men carry on their backs from house to house; this means for the abridgement of labour has not been invented more than ten or twelve years. Every German family stores up, according to its size, one or more large casks of this vegetable preparation. October and November are the busy months for the work, and huge white pyramids of cabbage are seen crowding the markets; while in every court and yard into which an accidental peep is obtained, all is bustle and activity in the concocting of this national food, and the baskets piled with shredded cabbage resemble "mountains of green-tinged froth or syllabub."

Sauerkraut has been found of sovereign efficacy as a preservative from scurvy during long voyages. It was for many years used in our navy for this purpose, until displaced by lemon-juice, which is equally a specific, while it is not so bulky an article for store.

The larger and grosser kinds of cabbage are used as food for cattle. But this nutriment has a great tendency to impart a disagreeable flavour to the milk of cows fed on it, and even to the flesh of other cattle. This unpleasant effect may, we are told, be prevented by removing the withered leaves; but cabbage is more disposed to fermentation and putrefaction than almost any other vegetable. When cultivated as food for stock, it is of course a matter of importance with agriculturists to produce the greatest weight in a given space. The average crop, as stated by Mr Arthur Young, is thirty-six tons per acre, when the plants are grown on a dry soil, which is very similar to that quoted from other and more modern writers; but on a sandy soil only eighteen tons have been obtained. Some cabbages are occasionally produced of an astonishing size and weight. A cabbage seed accidentally sown among onions came up in the onion bed, and without any care being taken of it, grew to very large dimensions, and weighed, when taken up, twenty-five pounds. A cabbage was also produced in Devonshire, two or three years back, which, when growing, occupied a space of fifteen feet of ground, measured five feet in circumference, and weighed sixty pounds.

A variety of brassica, under the name of cow-cabbage *(brassica oleracea*, var. *arborescens)*, has been recently introduced into this country from La Vendée by the Comte de Puysage. The proximity of this department to the ancient province of Anjou, and the description of the plant, leave no doubt of its identity with the Anjou cabbage, a very large variety described by Mill. In 1827 thirty-six seeds were divided among six agriculturists, for the purpose of raising this useful vegetable in England. The perfect success resulting from some of these seeds, which have produced plants of a luxuriant growth, is already known; and horticulture is now so much more disseminated and understood in this country, that there is every reason to hope that the cow-cabbage will at length become naturalized in

England. It is said that sixty plants afford provender sufficient for one cow during three or four years without fresh planting. A square of sixty feet will contain two hundred and fifty-six plants, four feet apart from each other, sixteen plants more than four cows require for a year's provender without the aid of other food. This plant is now successfully cultivated in Jersey, whence seeds have been sent to a nurseryman in London.

THE CAULIFLOWER *(brassica oleracea*, var. *o. botrytis)*, is the most delicate variety of the brassica genus. It was first brought into England from the island of Cyprus, where it is said to attain to high perfection, although it is not supposed to be indigenous to that country. The exact period of the introduction of this plant into English horticulture is not known; but it was certainly cultivated in this country at the beginning of the seventeenth century, although as a rarity, which could only be produced at the tables of the most opulent. In the year 1619, two cauliflowers cost three shillings, the price of wheat being at that time 35*s*. 4*d*. per quarter. It was not, however, until the latter end of the same century that this vegetable was brought to any degree of perfection; at least it was not raised in sufficient abundance to appear in our English markets until that period. The importation then of Dutch gardeners and Dutch gardening gave an impulse to English horticulture, which had been in rather a languishing state during the intestine troubles to which the revolution of 1688 put a termination. But although the Dutch gardening no doubt produced an improvement in the cultivation of the cauliflower, as well as in vegetables generally, this plant became more naturalized in England than in Holland, or any of the adjacent countries of the continent. Up to the period of the French revolution, cauliflowers were regularly exported from England into Holland, some parts of Germany, and even France; and while the seed of very many cultivated plants is in this country preferred, when it is of Dutch rather than of English produce, cauliflower seed obtained from England is the most esteemed in Holland, and indeed throughout the continent. The superiority of the English cauliflower is to be attributed solely to culture, and to culture carried on in the vicinity of London, not by experimentalists or amateurs, but by those who rear the plants for sale in the way of ordinary business. This vegetable is now cultivated very generally throughout the island; but since the portion of the plant which is used as food is not nearly as large as that of the cabbage, occupying an equal space, while it requires a richer soil and a warmer situation, it evidently can never become so cheap an esculent. Its delicate flavour is, however, in general much preferred to that of the cabbage, and it takes a higher rank in the list of culinary vegetables. Dr Johnson, whose most trivial and perhaps sometimes absurd remarks have been considered worthy of record, used to say, "Of all flowers I like the *cauliflower* the best."

This plant, like the common cabbage, is first raised in a seed-bed of light earth, and finally transplanted into soil which can scarcely be either naturally or artificially too rich. The seed is generally sown at the latter end of the months of February, May, and August, for three succeeding crops. The plants raised from seed sown in the latter month stand through the winter, during which season and the first part of spring they are usually protected under hand-glasses. In the neighbourhood of London it is not uncommon to see whole acres overspread with such glasses, fostering an early supply of this vegetable for the inhabitants of the metropolis, and conveying to the mind of the beholder a forcible idea of the riches and luxury of that vast city.

The head of the cauliflower is not nearly so liable to putrescency, after being cut, as its leaves, which in this respect are similar to those of the cabbage. For a considerable time after the leaves have become flaccid and in a state of decay, the head remains unchanged, and with care may be preserved without putrefaction for some months. By merely drawing up the plants entire, and hanging them in a cellar, they will continue in a sound state for a considerable time. The method most successfully adopted in Scotland, is to place the plants in layers in a pit, with their heads inclining downwards. The pit is then covered up closely with earth, beaten down, and smoothed in a sloping direction, so as to exclude both the rain and the atmosphere.

Brocoli is usually considered as merely a sub-variety of cauliflower; and that this is the case is rendered very probable from the great tendency of the plant to run into new varieties, which are constantly making their appearance, and as rapidly vanishing and giving place to others. It is a matter of common observation, that the more any plant has been changed by culture, the more readily does it admit of other changes.

But a few years back only two sorts of brocoli were recognised—the red and the purple, both of which originally came to us from Italy. Thirteen varieties are now enumerated as raised in the English garden, and each in turn is recommended to the notice of the cultivator by some characteristic quality. In the culture of no vegetable has so marked and rapid an improvement taken place as in that of brocoli. Horticulturists have recently succeeded in producing a hardy white variety, which has a handsomer appearance than either the green or the purple, while it is more delicate in flavour. White as well as purple are now obtained

throughout the winter, some attaining to the size, and equalling the cauliflower in appearance, though not in taste. The earliest spring crop follows without an interval the late winter crop, and no cessation need take place in the supply of brocoli, although, perhaps, it is not commonly raised during a month or two in the middle of the summer, when many other vegetables are produced in abundance.

Brocoli succeeds best in a fresh loamy soil; the seed-beds should be of rich mould, on which the seeds are thinly scattered, and covered with mats or litter till the plants appear.

The whole cabbage tribe are very liable to the attacks of various insects, such as slugs, snails, the *tipula* fly, and two species of butterfly, the large and small garden butterflies.

Sea Kale *(crambe maritima)*. This is a hardy perennial, found in various parts of the sea shores of England and Scotland. The common people on the western shores of England have from time immemorial been in the practice of watching when the shoots begin to push up the sand or gravel, in March and April, when they cut off the young shoots and leaf-stalks, then blanched and tender, and boil them as greens. The precise period of its introduction into the garden is unknown. Parkinson and Bryant state that the radical leaves are cut by the inhabitants where the plant grows wild, and boiled as cabbage; and Jones states that he saw bundles of it in the Chichester market in 1753. Maher states that the crambe maritima was known and sent from this kingdom to the continent more than two hundred years ago, by Lobel and Turner. About the year 1767 it was cultivated by Dr Lettsom, and by him brought into notice in the neighbourhood of London. It is now a common vegetable in the British markets, and it is also found in some of those of the continent of Europe and in America

The young spring shoots, and the stalks of the unfolding leaves blanched, by rising through the natural ground in a wild state, or by earthing up in gardens, are the parts used, and when boiled and dressed like asparagus, are not inferior to that vegetable. They form, also, an excellent ingredient in soups. Sometimes the ribs of the large leaves are peeled and dressed as asparagus, after the plant has ceased to send up young growths. By forcing, sea kale may be had in perfection from November till May. Vegetables are in general not improved by forcing; but, as Nicol remarks, the sea kale is an exception.

The native soil of this vegetable is deep sand, partially mixed with alluvial matter from the sea; hence this soil is to be imitated in garden culture. The ground is prepared, and the seeds sown early in the year. The plants come up in May; but cuttings are not obtained till the second or third year.

Mustard *(sinapis alba, s. nigra)*. There are two species of mustard in common use, the white and the black, both annual plants, indigenous to Britain, and found in abundance growing in the fields. The leaves are pinnatifid, the pods round and rough, and abruptly terminated. The flowers appear in June and July. The seed of the white mustard is larger than that of the black, and of a yellow colour. Mustard seeds are characterized by a pungent aromatic taste, which is derived from an essential oil of a peculiar kind. The tender leaves are used as a salad, and the ground seed as a condiment to food. Mustard is easily raised in a light soil, and repeated sowings give a succession of tender salad leaves in spring. The seeds strewed in moist flannel, put over a cup, will also quickly germinate, and will afford an agreeable salad in winter, or on board of a ship at sea.

Rape *(brassica rapus)*. This is a biennial plant, a native of Britain. It is distinguished by its glaucous root-leaves and yellow flowers, which appear in April. The leaves have a similar taste, and are used in the same way as those of mustard. An expressed oil is obtained from the seeds.

Garden Cress *(lepidum sativum)*. This is a hardy annual plant, not indigenous to Britain, but introduced about the year 1548. It is supposed to have come from Persia and the island of Cyprus, in both which it is native. This plant produces a number of small leaves, which are curled in some of the varieties, and plain in the others. The flowering stem is branched, and rises to the height of about a foot and a half, producing white flowers, which blow in June or July. It germinates very easily and rapidly, and is most commonly used when the leaves are young and tender, either alone or mixed with mustard leaves, and other salad herbs. The flavour of the cress is warm and pungent, hence it has received the name of pepper wort. During the greater part of the year a constant supply may be obtained by sowing a portion every week; and the application of a moderate artificial heat will furnish it throughout the winter.

Water-Cress *(nasturtium officinale)*. This plant is a creeping amphibious perennial, putting out rootlets at the joints of the stems. The leaves, which have a slight tinge of purple, are pinnate and rather heart-shaped. When the current in which they grow is rapid, the rootlets from the young shoots do not easily take root, and then a considerable portion of the plant rises above the surface of the water, and the form of the leaves alters. This is the case with many plants; when the leaf is near the ground it is broad, but when elevated it becomes longer and narrower. In water-cresses this change in the form of the leaves is sometimes followed by unpleasant consequences, since it then causes

them to be similar in shape with the joint-flowering water-parsnip *(sium nodiflorum)*, a plant which very generally grows mixed with the cresses, and has poisonous qualities. The leaves of the cress are however more smooth and shining, and are entire at their edges, while those of the parsnip are serrated. When the flowering stems are up, the plants are easily distinguished. The water-parsnip bears its flowers in umbels close upon the joints of the stems, while the flowers of the cress are cruciform, and rise into a spike. The four petals in the flower of the water-cress, and five in the parsnip, are also an obvious distinction. If they are in seed the parsnip has capsules, the water-cress pods.

In Europe the cress appears to have been first cultivated at Erfurth, about the middle of the sixteenth century, and in England in 1808, by Bradbury. It now has become an object of regular cultivation; and the demand of the metropolis, and of other large towns, for this favourite vegetable, will probably render the natural products of our brooks less and less in request. Few wild plants are the same under cultivation; but even when their qualities are not changed by the care of man, the cultivated sort soon supersedes the uncultivated. The cost of rearing them at will is less than that of searching for them under the difficulties which attend all spontaneous produce.

In a pretty valley called Springhead, situated in Kent, at a short distance from Gravesend, water-cresses are grown on a very extensive scale. The plants, neatly trimmed, growing in regular rows, and appearing under a limpid stream of purest water, give the idea of careful cultivation, and present themselves under a more pleasing form to be plucked for the table, than when found the inhabitants of ditches. For the purpose of this culture a clayey soil is selected, in which shallow beds, scarcely a foot deep, are made, having a slight inclination from one end to the other, and into which a small stream of water is introduced. At the bottom of these beds the cress is planted in rows, at about half a foot apart. Dams of six inches high are made at intervals across each bed, their number and frequency being regulated by the length of the bed and its degree of inclination, in such sort, that when these dams are full, the water may rise at least three inches over all the plants of each compartment. The water will thus circulate throughout, and the plants, if not allowed to flower, will furnish an abundant succession of young tops throughout the spring, summer, and autumn. A stream of water no larger than what will fill a pipe of one inch bore, will, if not absorbed by the soil, suffice to irrigate in this way an eighth of an acre. The water-cress, according to Mr Main, is cultivated in Hindoostan under sheds erected for the purpose.

Winter Cress *(barbarea vulgaris)*. This is a well known perennial plant, common in moist shady situations. The lower leaves are lyre-shaped, and the upper obovate and indented. The flower-stalk rises about a foot high, and produces yellow flowers from April to August. The whole plant is bitter and somewhat aromatic. A double variety is well known in the yellow rocket. The winter cress is used as a winter salad.

American Cress *(barbarea præcox)*. This is a native of Britain, similar to the winter cress, only it is an annual; the leaves, too, are smaller. It is called, also, French cress. Used the same as the others.

Scurvy Grass *(cochlearia officinalis)*, a British plant, common on the sea shores. The root-leaves are round, those of the stem sinuated. The whole plant is low and spreading, seldom rising above a foot. The flowers are white, and appear in April or May. It is used as a salad, and also, as the name implies, for the cure of scurvy.

The Radish *(raphanus sativus)*, an annual plant, said to be a native of China; but whether it was introduced from that country directly to Britain has not been ascertained. Bullein, who wrote in 1562, says, "Of radish roots there be no small store growing about the famous city of London; they be more plentifull than profytable, and more noysome than nourishinge to manne's nature." Yet notwithstanding this, they were used, thirty years before, at the table of Henry VIII. Gerarde thus describes the plant in 1584, "The leaves are rough, lyrate, or divided transversely into segments, of which the inferior less ones are more remote. The root is fleshy and fusiform in some varieties, in others sub-globular; white within, but black, purple, and yellow, or white on the outside; the flowers pale violet, with large dark veins; pods long, with a sharp beak." The tender leaves are used as a salad in early spring, and the succulent roots are now much esteemed. They soon, however, by age become hard and stringy, so that frequent sowings at intervals are necessary to ensure a succession of young and tender plants. There are several varieties: the spring, or early, are the long purple and long white; the white turnip and pink; the yellow turnip and round brown, being autumn sorts; and the white Spanish, oblong brown, and black Spanish, winter sorts. All the varieties are easily raised on light mellow soils.

Horse Radish (cochlearia armoracia). This is a perennial plant, growing wild in marshy places, and by the sides of ditches, in some parts of England. The radical leaves are large, oblong, crenate; the stalk-leaves long, lanceolated, and toothed, or cut; the root is large and fleshy; the pods elliptical. This plant has been long cultivated in gardens for the sake of its root,

which scraped into shreds is a well known accompaniment to English roast beef; it is also used in winter salads and in sauces. Horse radish thrives best in deep soft sandy loam, that is not very dry in summer, nor inundated in winter. The situation must be open. Two modes of cultivating it have been detailed by Messrs. Knight and Judd. Both agree in trenching the soil to a considerable depth, and putting the manure at the bottom of the trench; but Knight plants the sets on the surface, and calculates on the root that strikes down to the dung for produce. Judd, on the other hand, makes holes quite to the bottom of his trenched soil, and in each drops a set, filling up the hole with wood ashes, rotten tan, or sand, calculating for produce on the shoot made from the set at the bottom of the hole up through the sand or ashes to the surface. Judd's mode is the most ingenious, and appears the best; but either will do extremely well. A moist soil increases the bitter and alkaline flavour of this and all the cruciferæ. Horse radish forms an agreeable and wholesome condiment, at the same time serving as a vegetable adjunct to animal food, and affords a powerful stimulant to the digestive organs.

We have thus enumerated the principal nerbs belonging to the family *cruciferæ* which are used as the food of man; to these we subjoin a few other vegetables not belonging to the same family, but allied to them in their utility and habits.

The Beet *(beta cicla, B. maritima)*, a hardy biennial, belonging to the natural order *chenopodeæ*, including also the spinage, and to the class *pentandria*, order *digynia*, of Linnæus. The sea beet is a native of the British coasts, but is not very common. There are several varieties of the common beet.

The beet was known as an esculent root in the time of Pliny, who has given an accurate description of it in his work. The period when this plant was first introduced into Britain as a garden vegetable is not ascertained. It was cultivated at Lambeth, by Tradescant the younger, in 1656; but there is no reason for supposing that he was the first cultivator; on the contrary, it is more than probable that the beet was brought into this country by the Romans, and that it has continued since that period to be an object of partial cultivation.

The cultivated beets, in all their varieties, are plants of the same duration, and nearly of the same habits, as turnips. They are sown in the early part of the summer, bulb towards the close of the season, and, if allowed to stand, send up their flowering stems, and ripen their seeds in the following year.

The variety which has its root red throughout its whole substance is most used in England for culinary purposes. This plant is said to be a native of the warmer countries of Europe; but it is sufficiently hardy to bear the climate of most parts of Britain. The root is in the form of a carrot, but thicker in proportion to its length, those of a foot long often being three or four inches in diameter. It is very juicy, and, when wounded, bleeds freely a limpid fluid of a beautiful purple colour. The leaves are large, long, and succulent, and generally have a red or purple tinge. When eaten warm, beet-root has rather a mawkish flavour; it is, therefore, usually eaten cold, cut in slices, after having been previously boiled, and with the addition of vinegar is by some persons found agreeable to the palate. Its culture, as an esculent, has not, however, increased of late years, and it is not generally a favourite vegetable for the table; although, according to Sir H. Davy's analysis, it contains much more nutritive matter than any other root excepting the potato, the total quantity being one hundred and forty-eight parts in a thousand, or nearly fifteen per cent. Nearly twelve per cent. of the whole weight of the beet is saccharine matter, which is a much greater proportion than is contained in any other European esculent. The quantity contained in the red and the white beet is nearly the same; the proportion of mucilage in each is likewise almost equal, the red having rather the advantage, while it has nearly three times as much gluten as the white. From this account of its composition it would appear that the red beet is the most nourishing of all the edible roots, the potato alone excepted.

In a country like Britain, where, with the bulk of the people, vegetables are esteemed for their agreeable flavour, rather than for their nutritive qualities, the superiority of the beet, in the latter respect, is disregarded, and those roots which are considered more savoury obtain the preference.

The white beet is seldom, if ever, used as human food, but is largely cultivated for the nourishment of domestic animals, and is preferred for this purpose to the turnip or carrot, especially in the vicinity of populous towns. The field-turnip is esculent when young; the carrot is so in all stages of its growth; and, therefore, when grown amid a thick population, they form a great temptation to petty depredators, by which the farmer finds this provender for his cattle much diminished. The field-beet, however, affords no allurement to the hungry plunderer, as starvation itself could scarcely induce him to make a meal of this harsh, coarse root, previously to its being subjected to culinary preparation, and even then it would prove a most unpalatable repast. When cows are fed with the beet, it is said that they yield a greater quantity of milk in consequence; and this food does not impart any of that rank flavour which is communicated by turnips.

There are several varieties of the field-beet;

some with the stem, branches, and veins of the leaves red; others with leaves wholly red; and some, again, with the epidermis of the root in different shades of red, brown, and yellow. Those coloured varieties are considered more hardy than the white, and one, having a reddish skin, the *mangold*, or *mangol-wurtzel*, of the Germans, is said to produce the largest roots, and the most weighty crop in a given space of land. In Guernsey, crops have been raised of one hundred tons per acre.

Some varieties of white beet are cultivated in the gardens for their leaves alone; these are larger than the leaves of the red beet, and are more thick and succulent; they are boiled as spinach, and put into soups. One kind, called the great white, or sweet beet, is esteemed for the footstalks and midribs of the leaves, which are stewed and eaten under the name of Swiss *chard*, or *poirée aux carotes*.

Sugar has been manufactured in France from a variety of the beet, which has a red skin, but is white internally. The history of this sugar manufacture is thus detailed in a popular work.*

The celebrated Prussian chemist Margraff, about the year 1747, discovered the existence of a certain portion of sugar in the beet. This discovery was communicated to the Scientific Society of Berlin; but no attempt was made to carry the principle of the discovery into practice. Forty years after this, Achard, another Prussian chemist, resumed the experiments which Margraff had commenced. This man was somewhat of a visionary; and he was so enraptured by the prospects which his labours opened to him, that he announced the beet-root as "one of the most bountiful gifts which the Divine munificence has awarded to man upon the earth;" affirming that not only sugar could be produced from beet-root, but also tobacco, molasses, coffee, rum, arrack, vinegar, and beer. Here, then, was clearly nothing for Europe to do but to apply itself to the cultivation of beet, and leave the West Indies to be covered once more with jungle. The Institute of Paris, however, did not sympathise with the enthusiasm of Achard; for in 1800 a committee of that body, having gone through a series of the most careful experiments, reported that the results were so unsatisfactory that it would be unwise to establish any manufacture of sugar from beet.

Here, probably, the matter would have rested, and Europe would have continued wholly to receive its sugar from countries adapted to the growth of the sugar-cane, had not the decrees of Bonaparte, in 1809, excluded France from purchasing the produce of the West Indies. To a large number of the French sugar was an article of the first necessity; and the public dissatisfaction at the Milan decrees was therefore excessive. The emperor directed his active mind to the best method of obviating the inconvenience which his political schemes had imposed upon his people. Manufactories of syrups from raisins and honey were established; but sugar, or a crystallized saccharine substance, could not be procured. M. Deyeux, a member of the committee appointed by Napoleon to consider how the wants of the people could be supplied without foreign commerce, once more turned his attention to the beet-root. His experiments were more satisfactory than those of the committee of 1800; probably because the necessity of producing sugar at home was more pressing. An imperial manufactory of sugar was forthwith established at Rambouillet; imperial schools were instituted for instructing pupils in the process; premiums were given for the best samples of sugar; and thus, by 1812, the manufacture of beet-root sugar might be considered prosperously set on foot. The profits of the manufacturers were so large, that in one year they were reckoned sufficient to cover all the expenses of the original establishment. There was no competition. Of course these enormous profits were paid by the consumer. The French obtained some sugar, but they paid an extravagant price for the luxury. In 1814 Europe was at peace; the ports of France were again open to the produce of the West Indies; and in a moment the foreign sugar swept the beet-root manufacture entirely away. The consumers once more had cheap sugar; and the government had not then made the discovery that it would be a good thing to compel them to eat dear sugar, that the manufacturers of beet-root sugar might be kept in activity.

This cheapness was a natural and healthy state of things, which would be sure to provoke the meddling propensities of that class of rulers who can never believe that the interests of trade can take care of themselves. Immediately after the peace, sugar from the French, English, and American colonies was permitted to enter France at the same rate of duty. In a few months, however, it was found that the sugars from the English colonies were driving the sugars of Martinique, Guadaloupe, and Bourbon, out of the market. The colonies *must* be protected; so a protecting duty of twenty francs the 100 kilogrammes† was imposed upon all sugars of foreign origin. In 1816 the duty on foreign raw sugar was increased to forty-five francs; in 1820 to seventy-five francs; and in 1822 to ninety five francs, the 100 kilogrammes. The law of 1816 was the first bounty to the beet-root sugar manufacturers, and they accordingly once more be-

* Library of Entertaining Knowledge.

† A kilogramme is equivalent to 2 lbs. 2 oz. 4 drs. 13 grs. English avoirdupois.

gan to be active. But when the duty of 1822 upon foreign sugar amounted to a prohibition, their prosperity was certain. They were enabled to tax the consumer to the amount of the prohibition. The beet-root sugar pays no duty whatever. In 1829 there were 101 manufactories of this sugar in employment, which produced five million kilogrammes in the year, or about one-sixteenth part of the whole consumption of sugar in France. That the people of France are the sufferers by this miserable policy is sufficiently evident, from the fact that their average yearly consumption does not exceed four pounds of sugar per head: in the United Kingdom it is twenty pounds per head.

Upon the national advantage of that commercial policy which has given rise to the manufacture of beet-root sugar in France, and which may probably extend the system to Germany and Russia, we have much pleasure in extracting the following sensible observations from a valuable periodical work:—

"The history of this manufacture in France is an illustration, we apprehend, not of the natural progress of industry and of the arts, but of the effects of a system which counteracts the natural progress of both. Whatever may be the ultimate state of this singular manufacture, in consequence of mechanical and chemical improvements yet unknown to us, it is now only supported by a system of commercial and financial policy, which it is for the interest of all countries to see proscribed in Europe. The people of France were the first to be taught by their own philosophers those principles of mutual intercourse which form the basis of trade. Nearly a hundred years have elapsed since Quesnay and his followers taught his countrymen, that freedom of intercourse is the soul of commerce. But his countrymen have yet to learn that liberty is as necessary to the health of commerce as to the well-being of the citizen; that trade is but an interchange of things produced; and that if France will not take the productions of other countries, other countries will not and cannot take the productions of France. The cultivation of the beet is but one ramification of that system of repulsion and exclusion which has been adopted in France, to the oppression of her domestic industry, the ruin of her foreign commerce, and the maintenance of false principles in the commercial policy of surrounding countries."

Spinach, *(spinacia oleracea.)* The native country of the common spinach, and the time of its introduction into Britain, are not precisely known.

The west of Asia is assigned as its native country, but on what grounds are not very clearly shown, except that the earliest notice we find of it is in the works of the Arabian physicians, who of course only treat of its supposed medicinal properties, which might probably have originally led to its adoption as an edible vegetable. Spain is supposed to have been the first European country into which it was introduced, for many of the old botanists call it *olus Hispanicum;* while some writers, among whom is Ruellius, distinguish it as *atriplex Hispaniensis,* and the latter adds that the Moors call it *hispanach* or *Spanish plant.* According to Beckmann, the first notice of its being used as an edible substance in Europe occurs in the year 1351, in a list of the different vegetables consumed by the monks on fast-days: at that time it was written *spinargium* or *spinachium.* This plant found a place among culinary vegetables at rather an early period in England; for Turner, who wrote in 1568, mentions it as being at that time in common cultivation, and prepared for the table precisely in the same manner as it is at present.

Spinach is an annual plant, having large and succulent leaves: the flowering stems, which are hollow and branched, rise to the height of two or three feet. The male flowers grow on different plants to those of the female, which yield the seed. The former are produced in long terminal spikes, and the latter in close branches at the joints of the stem, or in the axillæ of the leaves and branches.

Two varieties of spinach are cultivated. The leaves of the one are arrow-shaped and rough, and of the other round and smooth. July and August are the months in which the seeds of both kinds would naturally come to maturity; but as they slightly differ in their qualities, it is found more advantageous to sow them at different seasons. The round leaved grows the fastest, is the largest and most succulent, and therefore is sown for succession crops in spring and summer; the other, being much more hardy, is preferred for winter supply. The former is usually sown in January, from which time until the end of July frequent sowings are made for a regular succession, from the beginning of April to continue throughout the summer. The rough-leaved is usually sown in August for a winter crop. The seed is sown broad-cast, and in subsequent culture the plants are thinned first to three inches apart, and as they increase in size that distance is doubled.

From the circumstance of the male and female flowers growing on different plants, when they are left to bring their seed to maturity, care is taken that a due proportion of each is suffered to remain. As soon as the seed capsules are set, the male plants are pulled up, thus allowing a freer space for the female plants wherein to perfect their seeds.

Wild Spinach, or *English Mercury,* or *Good King Harry, (chenopodium bonus Henricus.)* This plant, which has obtained so many names,

grows wild on a loamy soil, and may be found on way-sides and among ruins in many parts of England. The stalks rise to the height of a foot and a half; they are upright, thick, and striated, and covered with a whitish powder, which is likewise found on the under side of the leaves. These are arrow-shaped, and rather large for the size of the plant. The flowers, of a yellowish green colour, grow upon close spikes; they appear in June and July, and in August the seeds come to maturity. This plant is a perennial, and may be propagated by seeds or by offsets from the root. When young, both the stem and the leaves are succulent, the former being used as an asparagus, and the latter as a spinach.

Lincolnshire is the part of England where it is most in request, and where it is cultivated and preferred to the common spinach. It is, however, more nearly in a state of nature than the latter plant, and therefore cannot accommodate itself to differences of soil and situation.

The superior docility of a plant which has been long under cultivation, and which has travelled or borne changes of soil and climate in a growing state, is very apparent to those who attempt to rear wild plants in situations where they are not indigenous. This fact is so important a feature in the natural history of plants, that it is not perhaps sufficiently pointed out or explained in books treating on these subjects. It is a very natural result, which on consideration should not excite surprise, that a wild plant, which has been from time immemorial produced on the same spot, and has there accommodated itself solely to the circumstances of that spot, should refuse to grow in any other situation where the circumstances are not precisely similar. It is upon this principle that the mountain berry will not flourish upon the champaign country, and that the sweetest flowers of the woodlands refuse their odour to the parterre. In like manner, "good king Harry," which makes a very estimable spinach or asparagus in its native country, might make but a very sorry one if removed to a place where it is not indigenous.

New Zealand Spinach, (tetragonia expansa,) so called, because it was found growing wild on the shores of New Zealand when Captain Cook first touched at that island. Although the natives made no use of this plant as an esculent, the naturalists who accompanied the expedition were induced to recommend it as a vegetable which might be safely eaten, since its appearance and general characteristics were so similar to the *chenopodium*. On trial, it was found to be both agreeable and wholesome. Sir Joseph Banks brought it into culture in England in 1772, and it has subsequently been found to be a much more hardy and valuable plant than was at first supposed. It was at first treated as a green-house plant; but now grows freely in the open garden, and indeed seems already to have naturalized itself in the south-west of England. A writer, from Exmouth, observes, in the Gardener's Magazine for February, 1829, "the New Zealand spinach is quite a weed with us, as, wherever it has once grown, plants rise spontaneously, even when the seeds have been wheeled out with the dung in the winter, and again brought in as manure in the spring. I have now a full supply of it in my old pink bed." This spinach has an advantage over the common sort under cultivation, in producing an abundance of large and succulent leaves during the hot weather, when the latter plant runs almost immediately to seed, and produces little or nothing. It is likewise milder in flavour, and of so rapid growth, that a bed with about twenty plants is sufficient for the daily supply of a large family.

Though by some called a biennial, this spinach is an annual in our climate. The stem has numerous thick and strong branches, somewhat procumbent for the greater part of their length, but raised at the points. The leaves are fleshy and succulent, three or four inches long, of a dark green on the under part, but of a paler colour on the surface, on which the midribs and nerves are strongly marked. They are triangular, or rather of an elongated heart-shape, having the angles at the base rounded, and the apex sharp and extended. The flowers are small, and of a yellowish green colour; they appear in August and September. The whole plant is thickly studded with minute aqueous tubercles; a peculiarity likewise to be found in some species of *atriplex* and *chenopodium*.

In six weeks after sowing, some of the leaves of the plants are fit for gathering. These are pinched off, and not torn from the branches.

This plant has been likewise found growing on the Tonga islands; and Thumberg discovered it of spontaneous growth in Japan.

New Zealand spinach is remarkable as being almost the only native of the isles of Australasia which has been found worthy of a place in the kitchen-gardens of Europe.

Asparagus, *(a. officinalis.)* The name is derived from the Greek word *sparasso*, (to tear) on account of the strong prickles with which some of the species are furnished. Natural family *Asphodeleæ. Hexandria monogynia*, Linn.

It is found a native plant on the sea shores of Britain, and has been long cultivated as a favourite vegetable. This plant was much esteemed both by the Greeks and Romans. It is much praised by Cato and Columella; and Pliny mentions a sort which grew near Ravenna, a deep sandy district, three shoots of which weighed a pound.

Asparagus has a perennial root and annual stalks. The root is fleshy and succulent, com-

posed of round knobs, which are united together into a kind of tuber. This is seated deep in the ground, and is not liable to be much affected by the winter frosts. From this root, which contains turions or eyes somewhat analogous to those on the tuber of the potato, the stems rise up in the early part of the spring, and are cut for use when only a few inches above the ground. The shoot of an asparagus grows only from the extremity, and works or vegetates from the centre, and not from the surface as in trees. Thus it pushes up through the soil in one mass. The branches, which lie so thick together, safe and well protected under their scaly leaves, soon begin to be developed, and are drawn out until the whole plant, with its numerous thread-like leaves, assumes very much the character of a larch tree, having its miniature parts more light and elegant, and the colour of a more lively green. The flowers, which wave in graceful panicles, are of a yellow hue, and of a fragrant smell. They are followed by round berries of a bright orange-red.

The head of the young shoot of asparagus is edible just as far as the part which is to flower extends; and thus one who eats a head of asparagus eats in that little space the rudiments of many hundreds of branches and many thousands of leaves.

Asparagus is distinguished into two varieties, the red and the green: the first is a larger kind, growing fuller and closer; though handsomer in appearance, it is not considered of so good a flavour as the green. In consequence of its being more showy, it is, however, held in greatest esteem with market-gardeners. This kind has been cultivated with great success in soils consisting of little else than sea sand, dressed annually with sea-weed; and by attending to this mode of culture it is probable that asparagus might be reared on many spots on the coast, that will hardly produce any other vegetable.

A large quantity of asparagus is raised for the London market. Battersea, Mortlake, and Deptford, at each of which places the soil is light and friable, are the chief localities for its cultivation. The breadth of land in asparagus-beds, in the parish of Mortlake alone, is estimated to be nearly a hundred acres; one of the principal growers having sometimes forty acres under this crop. The largest cultivator in Deptford has eighty acres entirely laid out in asparagus beds.

Although the natural soil of this plant is poor and light, beds for asparagus can scarcely be too highly manured, since its good quality depends on the quickness of its growth, which is accelerated by richness of soil. It is propagated by seed, which is sown broad-cast in spring; and at the same period of the ensuing year the young plants are transplanted to beds prepared for their reception, and where they are allowed to remain three or four years before the tender shoots are cut for use. When these are from two to four inches above the ground, they are cut two or three inches below the surface. In cutting, care is taken to leave to each plantule or stool one or two shoots, to grow up into flower and seed, or otherwise the roots would perish. Under good culture, the same plants will continue to furnish annual crops during twelve or fourteen years. It is estimated by a practical gardener that five square poles of ground, planted with sixteen hundred plants, will yield, during the season, from six to eight score heads daily.

Asparagus contains little nutriment, but it is a mild vegetable, and pleasant to the taste. Its culinary preparations are few, its very delicate flavour rather being deteriorated than improved by other adjuncts.

The Artichoke, *(cynara scolymus.)* This plant belongs to a well marked natural family, the *Compositæ*, and the *Syngenesia aqualis* of Linnæus, all the species of which are characterised by the adhesion of their anthers forming a tassel or button-shaped mass, as in the thistle, daisy, dahlia, crysanthemum, &c. The form of the artichoke most nearly resembles that of the thistle. The name is supposed of Arabic origin, the plant being called in that language *kharchiof.*

The artichoke is evidently not indigenous to Britain, but is probably a native of some of the warmer parts of the temperate zone, and is supposed to be indigenous to the countries which bound the Mediterranean, as well as to the islands which are situated in that sea.

Like sea-kale, it is naturally a maritime plant, or at least one which thrives best on soils where there is a mixture of saline or alkaline matter. It does not, however, flourish on the same sandy shore with the former plant, its most genial soil being that in which there is a mixture of peat, or other decayed marshy vegetable matter. No where does the artichoke arrive at greater perfection than in the Orkney islands, and this successful culture is said to be consequent on the plentiful supply of sea weed with which the ground is annually dressed.

Beckmann made very laborious researches to ascertain the positive antiquity of the artichoke. These discussions are, however, more curious than interesting. A commentator of Dioscorides, Hermolaus Barbarus, who died in 1494, relates that this vegetable was first seen in the Venice garden in 1473, at which time it was very scarce. A few years previous to that time it was, however, an object of cultivation in other parts of Italy. It was introduced into France at the beginning of the sixteenth century, and not many years afterwards, during the reign of Henry VIII., was first transplanted into our gardens. In the Privy-Purse expences of this

king we find several entries regarding artichokes. Thus:—"Paied to a servant of maister Tresorer in rewarde for bringing Archecokks to the king's grace to Yorke place, iiij*s.* iiij*d.*" A treatise, written in the reign of Mary, on "the best settynge and keepynge of artichokes," is still preserved in the Harleian library, of which it forms the 645th number. Though in very common culture in this country this plant is not held in as much estimation here as on the continent.

The artichoke has large thick perennial roots and annual stems, rising to three feet or more in height. The leaves are large and pinnatifid, or cut in deep, horizontal, convex segments; these are covered with an ash-coloured down. In the midst of them rise the upright stalks, which are surmounted by large, scaly heads, composed of an involucrum, having numerous oval leaves or scales, enclosing the florets, and placed on a broad, fleshy receptacle; this, and the lower part or *talus* of the scales, are the only edible portions of the plant used in the early stage of their growth, before the central leaves of the calyx are separated, or the flowers in any way exposed. A large portion of the centre is occupied by what is vulgarly called the choke, which consists of the young flowers and seed-down, having the appearance of bristles or prickly filaments, and from which the receptacle, or bottom, must be entirely freed before it can be eaten.

Artichokes are most readily propagated by offsets from the roots of the old plants, from which they may be separated, and planted out anew in March or April, when they have attained a height of about five inches. They will produce a crop the same year, but not an abundant one, commencing in August, and continuing till November; the second year they will be in full bearing, and produce two months earlier. Thus by planting fresh offsets every year, a succession of artichokes may be obtained from June to November. The old plants, however, will continue productive for many years, provided the ground be annually manured at the winter dressing. But although the heads may be obtained from roots twenty years old, they degenerate in size and abundance with the age of the plant, and therefore it is advisable often to renew the plantation.

The artichoke is one of those plants most partial of drought. Once in the 17th century, and again, about 1739, most of the artichokes in England were destroyed by frost, but were replaced from France. There are three varieties in cultivation, the conical or oval, the globe with a large dusky, purplish head; and the dwarf globe, a smaller variety, but very prolific.

The Cardoon, *(cynara cardunculus,)* is a native of Candia, whence it was introduced into England, but not until more than a century after the artichoke. Its cultivation has never, however, been an object of much attention in Britain, where it is considered of little value. On the continent this vegetable takes a higher rank, and is much more extensively used. The stems of the young leaves, rendered mild and crisp by blanching, are the only edible parts of the plant; these are stewed or used as an ingredient in soups and in salads.

The cardoon very much resembles the artichoke in appearance; but it is of a larger and more regular growth.

Scorzonera *(scorzonera hispanica)*, is indigenous to Spain. It was introduced into this country some years after the skirret, and, like it, was formerly more cultivated than it is at present. Its root has not, however, the peculiar sweetness of the latter, but is extremely delicate, and when properly prepared makes so pleasant an addition to the list of culinary vegetables, that it appears to be unjustly excluded from our gardens. It has shared the fate of those vegetables which, according to Beckmann, have been banished by fashion; "for this tyrant, which rules with universal sway, commands the taste, as well as the smell, to consider as intolerable articles to which our ancestors had a peculiar attachment."

Scorzonera was first known on account of its supposed medicinal properties, but was afterwards cultivated as food in consequence of its agreeable flavour. It was applied to this first purpose, in the middle of the sixteenth century, in Spain, where it was esteemed as an antidote to the poison of a snake, called there *scurzo.* A Moor, it is said, who had learnt in Africa that this plant possessed so valuable a property, availed himself of the knowledge in effecting many cures with the juices of the leaves and roots upon peasants who had, while mowing, been bitten by these venomous reptiles; but he carefully concealed the plant, that he might retain to himself all the honour and the profit attendant on the discovery. He was, however, clandestinely followed to the mountains, where he was observed to collect this plant, to which the name of scurzonera, or scorzonera, was then given, from the name of the snake, the venom of which it was believed to render innocuous. The knowledge was quickly disseminated. Petrus Cannizer transmitted the plant, together with a drawing of it, to John Oderick Melchion, physician to the queen of Bohemia; and he, in his turn, lost no time in sending it to Matthioli, who had not any previous knowledge of the plant.* Soon after this Nicholas Monardes published a tract, in which the particular virtue of these roots was panegyrized. It is probable that in Spain their adaptation as an edible substance was likewise first discovered; and thence, about

* Matthioli Epistol. Medicinal.

the beginning of the seventeenth century, it was introduced into France. The author of "Le Jardinier François," who was a practical as well as theoretical gardener, assigns to his own exertions its first cultivation in the French gardens. Scorzonera is at present much more used on the continent than in this country; its medicinal virtues are now, however, but little regarded.

This plant is a hardy perennial, with a stem from two to three feet long, and having yellow flowers, which continue to bloom from June to August. The lower leaves, which are linear and pointed, are about eight or nine inches in length. The root is thin and spindle-shaped, covered with a dark brown skin, but white within, and containing a milky juice.

Though the plants are perennial, producing offsets from the crown of the root, it is better to propagate from seeds, in the same manner in which carrots are cultivated, since the offsets degenerate from year to year, both in size and quality. The roots, like those of parsnips, remain uninjured in the ground throughout the winter, and till they begin to put out fresh leaves in the spring. The whole plant is somewhat bitter. To divest the roots of that quality, they are scraped, and then steeped in water previously to their being made to undergo any culinary process.

Lettuce *(lactuca sativa)*. This plant also belongs to the family compositæ. It is a hardy annual, introduced into English gardens in 1562, but from what country is unknown. Some consider it derived from one of the three species native to Britain, most probably from *lactuca virosa*, which it closely resembles.

The leaves are large, milky, frequently wrinkled, pale green, but varying in form in the numerous varieties. The general name *lactuca* is derived from the milky juice which it contains. This juice possesses a slightly narcotic principle, which is in general elaborated only in small quantities during the early stages of the plant, but increases greatly as that advances towards flowering. This juice is very bitter, and when it becomes abundant, the plant ceases to be useful.

The absolute quantity and strength of the opiate portion of the juice most probably varies both with the variety of the plant and with the soil on which it is produced. In the strong-scented wild lettuce *(lactuca virosa)* the narcotic juice is so abundant, and so acrid in itself, or so mixed with other acrid principles, as almost to bring the plant within the class of vegetable poisons.

The narcotic principle of lettuce-juice has been long familiarly known. It is only very recently, however, that this juice, inspissated, or the extract of lettuce, has found a place among our pharmaceutic preparations, under the name of *Lactucarium*. It is supposed to possess, though in an inferior degree, the virtues of opium, without producing the same deleterious effects; and therefore it is held that it may be safely administered in cases where the more powerful medicine is not desirable, or even admissible.

As soon as the flower-stems have attained a considerable size and height, but before the flowers begin to expand, a portion of the top is cut off transversely. This operation is performed when the sun has excited the plants into powerful action. The milky juice quickly exudes from the wound, while the heat of the sun renders it immediately so viscid, that it does not flow down in a fluid state, but concretes around the part whence it issues, forming a brownish scale, about the size of a sixpence. When it has acquired the proper consistence it is removed, and as the inspissated juice closes up the extremities of the divided vessels, it is necessary to cut off another small piece of the stem; this causes the escape of the juice again, and another scale is formed. The same process is repeated as long as the weather is favourable, or the plant will yield any juice.

Under so variable an atmosphere as that of Britain, a crop of this kind must be precarious, unless in those places where there is generally a week or two of settled drought about the warmest period of the year, and where the cultivator has sufficient local knowledge for enabling him to time the state of his plants accordingly. Mr Henderson, the Brechin cultivator, an intelligent and experienced horticulturist, states, that in favourable years the lettuce-opium, notwithstanding the trouble of collecting it, is much more profitable than any other crop that comes to maturity in so short a time, upon the same breadth of land.

Turner mentions the lettuce as being, in 1652, not a rare or recently cultivated plant, but one with which the public generally had been long familiar. In the privy-purse expenses of Henry VIII., in 1530, we find that the gardener at York Place received a reward for bringing "lettuze" and cherries to Hampton Court. Although it cannot now be definitely ascertained when or how this plant was first introduced into England, we are no doubt indebted for some of its varieties to the Greek islands. The Cos lettuce, as its name indicates, is a native of the island of Cos, and was most probably brought thence into this country.

The culture of this plant is so simple, and it requires so little space, that a garden of the most humble dimensions is seldom found without having a small nook appropriated to this cooling and agreeable vegetable. There are many varieties of the lettuce, very nearly twenty being enumerated as objects worthy of garden culture, and each of them differing somewhat in colour, shape,

or some other circumstance attending its growth. These, however, may all be ranged under two distinctive heads, the *cos* and the *cabbage* lettuce. The former grows upright, and its leaves are of an oblong shape; the latter has rounder leaves folded together, and forming a low, full head, spreading out close to the ground. When in perfection for gathering, the leaves of both sorts are lapped one over the other in a compact, close order, forming what is usually called the *heart*, the inner part of which, being thus excluded from light and air, becomes nearly white. This natural blanching is often assisted by artificial means, and when the inner leaves begin to close, the outer ones are tied round them with a piece of *bast*.* The blanching prevents the formation of the bitter or acrid principle, which is very perceptible in all the varieties, if allowed to remain in the ground and complete their growth, when the leaves expand and the flower-stalk begins to ascend.

Lettuce being a hardy and free growing plant, may be obtained early in the season, if sown in a warm border, and protected from the frost during the night. For early use the cabbage is the best, as in that stage it is more delicate in flavour than the other; but when both have arrived at maturity, the *cos* is the most succulent.

Endive *(cichorium endivia)*, is abundantly cultivated, if not found wild, in China and Japan; and thus the accounts that describe it as a native of those countries, and as having been imported into the West about the early part of the sixteenth century, have probability on their side. Few particulars of the history of this plant are, however, known.

It is a hardy annual, producing a great stock of leaves from the crown of the root. These leaves are large, smooth on the surface, but much divided into lobes, and toothed at the edge. The flowering stem rises to the height of about two feet, and the flowers, which are of a pale blue colour, bloom in July and August. Like the lettuce, its leaves are used as an edible before its flowering stem begins to appear. These leaves are very harsh and bitter when exposed to the air; they are therefore blanched, and if this be properly performed, they become crisp and tender, and retain only an agreeable bitterness. Endive may be blanched for use by tying the leaves together, by earthing up the plants, or by covering them with pots. By judicious culture and a succession of sowing, endive may be obtained during autumn, winter, and spring. It is considered a valuable salad at a time when few other vegetables are furnished for the table; and it also serves as an ingredient in some other culinary preparations.

Succory, Chicory, or Wild Endive *(cichorium intybus)*. There is little doubt that the *cichorium*, as mentioned by Theophrastus, in use among the ancients, was the wild endive, since the names by which this plant is known in all the languages of modern Europe are merely corruptions of the original Greek word; while there are different names in different countries for the garden endive.

Succory is a hardy perennial plant, not uncommonly growing about the edges of fields, in those parts of England where the sub-soil is lime. It will bear all the varieties of climate in Europe, being cultivated from Italy to St Petersburgh. This plant has a strong and fleshy root; the leaves have some resemblance to those of endive, differing only in being narrower, more feathery at the edges, and having the mid-rib beset with hairs. The flowering stem rises much higher, sometimes attaining to five feet in height; the flowers are like those of the garden plant in appearance, as well as in time of blooming.

This plant is not much valued or cultivated in Britain. On the continent it is held in greater esteem, and is used as an edible vegetable in a variety of ways.

Both in France and England succory has occasionally been cultivated as food for cattle; it is in a proper state for this purpose just as it is coming into flower.

The root of this plant is used as a substitute for coffee; and it is sometimes considered superior to the exotic berry. In many parts of Holland and Germany this prepared root is used in large quantities, either alone or mixed with coffee, by those who cannot afford to indulge in the latter luxury in its genuine state. Indeed, it has been very recently introduced into this country as an addition which much improves the flavour of coffee; but where economy is not the consideration, it is not likely to gain much esteem. The succory root, when applied to this purpose, is merely cut in pieces, and sufficiently dried to admit of its being easily ground.

Rhubarb *(rheum)*, belongs to the natural family *polygoneæ*, and the class *enneandria*, and order *monogynia* of Linnæus. Of this well known plant there are several varieties. The petioles of rhubarb have a pleasant acidity; these, when peeled and cut into pieces, form no unworthy substitute for fruit in spring tarts; to furnish a supply for which this plant is now largely cultivated in the vicinity of the metropolis.

Several species of *rheum* are cultivated in England. The root of the true rhubarb *(rheum palmatum)* is well known as a medicinal drug, and for that purpose has long been imported from the Levant, though the particular plant of which

* The material of Russia matting, made from the inner bark of the lime tree, and which is a well known essential in kitchen-gardens.

it was the root, was not ascertained until 1758, when it was first introduced and cultivated in this country by Dr John Hope. It is a native of some parts of Tartary, where the physical characters of the climate are well adapted for the perfecting of its root, the properties of which are very faintly retained in countries where the season of dormant vegetation is humid. This plant is of very handsome appearance. Its beautiful palmate leaves distinguish it from the other species; but as the parts used for culinary purposes, the footstalks of the radical leaves, are much smaller than those of the other kinds, it is not in general cultivation.

Monk Rhubarb, (rheum rhaponticum,) is also a native of Asia, but of what particular part is not known, neither is the time of its introduction ascertained; we find it mentioned by Tusser so early as 1573, as being then cultivated in England.

The leaves of this species are blunt and smooth, with red veins; the footstalks have also a red tinge, they have a groove or furrow on their upper sides, and are rounded at the edges.

The *Hybrid Rhubarb, (rheum hybridum,)* is a native of more northern parts of Asia than the others, and is of more recent introduction into Britain. It was first cultivated in this country by Dr Fothergill in 1778, but it did not come into general use as a culinary vegetable till several years after, having been introduced in our kitchen-gardens for this purpose about thirty years back. This plant is of a much more lively green than the former species. The leaves are slightly heart-shaped and very large, being, in favourable soils and under good culture, sometimes as much as four feet in length, including the footstalk. In the Gardener's Magazine for February, 1829, we find a notice of a plant of this species, the leaves of which attained to great dimensions. One leaf being cut, with its petiole, was found to weigh four pounds. The circumference of the leaf, not including its foot-stalk, measured twenty-one feet three inches; its diameter, three feet ten inches; length of leaf, including the petiole, five feet two inches, and length of petiole, one foot four inches. The stalks of the hybrid are much more succulent, as well as larger, than those of the monk rhubarb, which, therefore, cause it to be the preferable species for cultivation, although *rheum undulatum*, called by gardeners Buck's Rh., and the Elford Rh., has been found the finest in flavour.

Rhubarb is very easily cultivated, and though it occupies much space, the produce, under proper treatment, is very considerable. The petioles obtained from it will furnish a greater supply of material for tarts than the fruit of either apple or gooseberry-trees occupying an equal breadth of ground. It may, therefore, be considered as a good plant for the cottage garden, more especially as it comes into productive bearing in the earliest spring, a time when fresh fruit cannot be obtained.

New plantations may be raised either by sowing the seeds or parting the roots. The latter is not, however, an eligible mode of culture. As in most cultivated plants, the produce of a sucker is, when it has to make its own root, always inferior in vegetative power to that which is originally from the seed, and vigorous vegetation is the quality most sought for in rhubarb; the flowering stems should be removed, except in such plants as may be wanted for seed. If the seeds are sown in spring, the plants will be ready for planting out in autumn, and will come up strong enough for use the next spring, after which the plantation will last for many years. The plants of the hybrid kind require from two feet and a half to three feet of space for each, and those of the other species about a foot less; but the superior produce of the former, under favourable circumstances, will more than compensate for the greater breadth required.

Angelica, *(angelica archangelica,)* is occasionally to be found native in cold and moist places of Scotland; but it is more abundant in countries farther to the north, as in Lapland and Iceland. This plant was formerly much more in repute than it is at present. It may be inferred from its common name of angelica, as well as from another name, "The Holy Ghost," which was sometimes given to it, that superstitious virtues were imputed to it. The chief of these virtues was driving away the pestilence, for which general cleanliness has proved to be a better preventive than all the charms which ever were named.

Its stem was formerly blanched and eaten like celery, but the use of this plant in the present day as an English edible is mostly confined to confectionary, for which purpose the young and tender stalks are candied. The roots, seeds, and leaves, are sometimes, though not very commonly in modern practice, used in medical preparations. The whole plant is highly aromatic. In Lapland the inhabitants consider the stalks of angelica as a great delicacy. These are gathered before flowering; the leaves being stripped off and the peel removed, the remainder is eaten with much relish. This is a favourite plant with the Laplanders, who have given so many names to it, according to the different stages of its growth, as to occasion much confusion to a stranger.

Sorrel, *(rumex acetosa.)* An indigenous perennial plant, very common in meadows and moist places. The root leaves have long footstalks, are narrow shaped, blunt, and are marked with two or three large teeth at the base: the upper leaves are sessile and acute. There are several varieties of this species; the broad-leaved is the most succulent.

The French sorrel, or round leaved, is the *rumex scutatus*, with somewhat hastate blunt leaves, cultivated in gardens.

Both sorts are used in soups, sauces, and salads; and by the French and Dutch as a spinach. The succulent stalks may also be used like those of rhubarb for tarts.

CHAP. XXXIII.

LEGUMINOUS PLANTS,—THE PEA, BEAN, KIDNEY-BEAN, VETCH, LENTIL, LUCERN, CLOVER, &c.

THERE is a great variety of most important plants which have been grouped under the natural family *Leguminosæ*. The form of the corolla called *papilionaceous*, from its shape resembling a butterfly, characterises a large number, as the pea tribe; and the pinnate leaves and pods include the remainder, as the mimosæ, and similar shrubs. Though there is thus a marked resemblance in structure, yet the family includes plants possessing very opposite properties, some being bland and nutritious, as the pea, bean, and others of the same tribe; while others are purgative, emetic, and otherwise highly stimulating to the animal system. As objects of ornament many are possessed of unrivalled beauty; such, among the trees and shrubs, are the laburnum, robinia, cytisus, and amorpha; among hardy climbing plants the far-famed glycone of China, and its sister of North America, with the numerous more lowly herbaceous families of vicia and lathyrus; the numerous kinds of lupines and astragalus. Great, however, as is the beauty of these plants of the temperate regions, it must give way before the splendour and elegance of similar inhabitants of the tropics. The flowers of the erythrina or coral tree, are of the deepest crimson, and wave in profusion upon some of the loftiest trees of the forest. The bauhinias, with their snake-like stems and turn leaves, hang in festoons of flowers from branch to branch of other trees, and are only rivalled by the less vigorous and elegant, but more richly coloured blossoms of the carpofagus. But all these, with their broad foliage and gaudy colours, are far surpassed by the rugged trunks, light trembling foliage, and golden flowers of the mimosa, which cast a rich glow over even the most sterile deserts of burning Africa. While the tropical forests are thus adorned, the meadows and pastures of the same latitudes are enamelled with the flowers of myriads of hydesarumous and sensitive plants, shrinking on the slightest external touch, like beings of a higher and animated order. As in our own country, the gayest part of our scenery is in many places indebted to the yellow blossoms of our furze and broom; so in those regions other leguminosæ, as the liparia, barbonia, aspalathus, davisias, and aoluses, spread profusely their gay blossoms to the common gaze. The trees of this family have a very hard and durable wood, of a yellow tinge, sometimes passing into green, as in the laburnum and Brazil wood.

117.

The pulses, vetches, and similar families, all afford seeds containing a farinaceous matter, some with a considerable quantity of oil. The pulp of the tamarind and other mimosæ, are more or less purgative, and are used in medicine. The leaves of senna also afford a well known purgative. The astringent substance called catechu, is the expressed juice of a mimosa, as well as the gums tragacanth and Arabic, the latter being of a bland, mucilaginous nature.

Several of the same tribe yield balsams, as the balsam of Tolu and Copaiva. Indigo, liquorice, logwood, are all derived from plants of this family.

The Liguminosæ are included in the class *Diadelphia*, order *Decandria*, of Linnæus. The family has been arranged into three natural tribes, thus:

1. *Papilionaceæ*. The corolla formed of five unequal petals, constituting the irregular or papilionaceous corolla, with the stamina generally diadelphous, as the bean, robinia, astragalus, &c.

2. *Cassieæ*. Corolla generally formed of five regular petals; the ten stamina usually free, a cassia, bauhinia, &c.

3. *Mimosæ*. Containing the apetalous genera, furnished with a calcyform involucrum; stamina very numerous, and free, as the mimosa, acacia, inga.

As we shall consider many of the genera of this family under other heads, we confine our descriptions at present to the liguminous plants used as food.

THE LEGUMES, or PULSES, are, perhaps, next to the cerealia and the potato, the most important of esculent vegetables. They are numerous, most universally diffused, and many which are not applicable for human food can still be advantageously used as nourishment for domestic animals.

The whole of the edible legumes, with the exception of some of the species which grow on trees, have papilionaceous flowers. The seeds are contained in an oblong legumen, or pod, consisting of two valves, on the upper suture of which they are placed alternately on each side. These seeds, in germinating, have no power of pushing forth more than one stem, as in the case of the cerealia, so that the pea does not tiller,

but the buds on the stem produce fertile branches.

It is said that carbonic acid gas is generated in great abundance when leguminous plants are in the highest vigour of vegetation. The quantity of this gas which is then given out, and more especially during the period of flowering, is very considerable, and being heavier than atmospheric air, it is carried along the surface of the earth into pits and cavities, in the same manner as a flood of water would be carried, only that its effects are the sole indications of its presence,

It is said that miners, in fertile districts where legumes are extensively cultivated, are but too well aware of the production of this mephitic gas, of the noxious effects of which they are sometimes made fatally sensible. Under particular states of the weather, which are known to the overseers from experience and observation, the men do not then go to work until a fire-grate has been let down in one of the ventilation pits, as deep as the rooms or galleries in which the operations are to be carried on. If the fire in the grate will not burn, of course their labours are suspended, until, by the play of the atmospheric current between pits at different elevations, the superabundant carbonic acid gas is removed.

The principal legumes cultivated in Britain are the pea, the bean, and the kidney-bean; which, according to the analyses that have been made, contain quantities of nutritive matter, diminishing in the order in which they have been enumerated, and all of them much less than any of the cerealia.

Peas contain fifty-seven and a half per cent. of nutritive matter, a proportion of which is saccharine. Beans have very nearly as much nutriment, but it is not entirely composed of the same principles. No saccharine matter ready formed is found in this vegetable, which is considered a coarse though nutritive esculent. Kidney-beans do not contain more than nine per cent. of nutritive matter.

THE PEA *(pisum)*, from the Celtic word *pis*, a pea, is a climbing plant, furnished with tendrils, issuing from the terminations of the compound leaves, and which, clinging round bodies in their vicinity, afford support to the otherwise recumbent stems. There are several species, and a great many varieties of the pea. Among the species are, the common pea, *pisum sativum;* the sea pea, *pisum maritimum;* the Cape Horn pea, *pisum Americanum;* the yellow-flowering pea, *pisum ochrus.* The varieties of the common pea are numerous, and differ widely among themselves from the early *frame,* a low plant, bearing only one white blossom on each footstalk to the *crown,* bearing heavy pink blossoms on a terminating corymb. The rouncival grows ten or twelve feet high, and the imperial not two feet. The sugar pea has pods, in which the inner film is wanting, or much less tough than usual, which admits of boiling the pods entire, and eating them in the same manner as kidney beans.

The Common Pea (pisum sativum). Like many of our most familiar domestic vegetables, the period of the introduction into Britain, or even the native country of this vegetable, is involved in obscurity. It is probable, however, that it was introduced into Britain from the warmer parts of Europe, and may have been brought to these from Egypt and Syria. It is known in India, China, and Cochin China; but it is not very plentiful in those places, and there is no evidence of its being a native plant. It is more abundant in the Japan isles, the climate and soil of which agree better with its habits; and therefore there is reason to conclude that it is not a native of very dry and burning regions; neither is it the offspring of very frigid climes, since it is soon affected by cold, severe weather, and the leaves become blackened by the autumnal frosts.

Historical evidence would make it appear that both the pea and the bean must not only have been introduced, but extensively cultivated, in some parts of Scotland, as well as in England, at a very early period. It is on record, that when the English forces were besieging a castle in Lothian, in the year 1299, their supply of provisions was exhausted, and their only resource was in the peas and beans of the surrounding fields. This circumstance would lead to a belief that the pea was then one of the staple articles of produce for human food.

The more delicate kinds, however, do not appear to have been cultivated in England until a much later period, since Fuller informs us that peas, in the time of queen Elizabeth, were brought from Holland, and were "fit dainties for ladies, they came so far, and cost so dear." In the reign of Henry VIII., too, the pea would appear to be somewhat of a rarity, as in the privy purse expenses of that king is an entry, "paied to a man in rewarde for bringing pescodds to the king's grace, iiij*s.* viii*d.*" From a song, however, called "London Lyckpeny," made in the time of Henry VI., peacods appear to have been commonly sold in London:

> "Then unto London I dyde me hye,
> Of all the land it bearyeth the pryse;
> 'Gode pescode,' one began to cry."

At Windsor there is a street called "Peascod," mentioned by that name in old documents.

The use of the pea as an esculent, both in its green and its dried state, is too familiar to need description. This plant is annually cultivated to a great extent in Britain; perhaps, since the more general introduction of the potato, a dimi-

nution of peas culture may have taken place in the poorer districts; but peas are always in constant requisition in this country. They are consumed in immense quantities as sea-provisions; they are likewise largely supplied to hospitals, infirmaries, and work-houses, and are in familiar use in every private family.

The principal varieties of the common pea are the white or yellow, and the gray. Soil and culture have probably produced all the varieties under the two sorts, different as they now are, both in their colours and their qualities, and even in the number of flowers and pods growing from each peduncle.

Among gray peas, where much attention has not been paid to the purity of the seed, it is not unusual to find several shades of colour, from a deep purple, almost approaching to a black, to a very pale or nearly white hue. In even the same parcel, some seeds are gray, some mottled, and others purple.

The white and yellow peas are distinguished as garden peas and field peas. The former being the choice sorts, are raised by more careful and expensive culture for the purpose of being eaten green; the latter, inferior chiefly on account of the manner of their being raised, are allowed to come to maturity.

The sub-varieties of the common pea are never-ending. These have obtained their names, some from imaginary qualities, some from the peculiar mode of culture, others from the persons who first produced them, and some from more fanciful distinctions. Of those no less than twenty-two are enumerated as being objects of garden culture, differing in the colour of the flowers, height of the haulm or stalk, time of coming to maturity, produce of legumes, or size and flavour of the seeds. The varieties are in different degrees tender or hardy; if, then, a due regard be paid to the choice of soil and situation, and the time of sowing most favourable to the respective kinds, the success of the crop may, in a great measure, be commanded.

The most useful varieties are:

Dwarf growing Peas—early.

Early Frame.
Early Warwick.
Early Charlton.
Bishop's Early Dwarf.
Dwarf Spanish.

Tall growing Peas.

Tall Marrowfat.
Knight's Tall Marrowfat.
Green Imperial.
Wellington.
Egg.
Tall Crooked Sugar.

The varieties of the garden peas may, therefore, be divided into early and late. The former are distinguished as being more slender in the plant, and less abundant in the crop, but they are more hardy, and can better withstand the cold weather; while some kinds admit better of being forced, and thus can be produced at the earliest approach of summer, as the grand vegetable luxury of the season. The late sorts are more vigorous and more productive, both in the number of the pods and the size of the grain; and as they come to maturity by the natural heat of the season, and in a free change and circulation of the air, they are more rich and saccharine. Thus it happens, as is the case with many other articles of human food, that green peas are really of the best quality when they are so cheap that they may be purchased by the people generally.

The pea goes through all the stages of its vegetation in a very brief period. More than one instance is on record of a crop being obtained from seed matured the same season. Some Spanish dwarf peas were sown in February, and the crop was reaped the first week in July; some of the pods were left to mature their seed, which, when sufficiently ripe, were again committed to the earth on the same piece of ground, and a second crop was reaped on the 27th of September.

To obtain the very earliest crops, the seeds are sown in a dry soil, about the end of October; in favourable situations and seasons they stand through the winter, and if the spring be a forward one, they may be ready for gathering about the end of May. They are a precarious crop, however, and do not pay the cultivator, unless they are produced so early as to command a very high price. In consequence of the uncertainty of the winter, in places where the demand is such as to bear the expense, the earliest peas are brought forward in hot-beds.

The gray, or field pea, so much cultivated in agriculture, is by some considered as a distinct species, though it is obviously a mere variety,* not farther removed from the frame pea than is the blue Prussian, or the crown pea. A dry soil and season are essential for a good crop, unless the plants can be supported by sticks, like the garden crops. The seed is chiefly used for feeding pigs, and splitting for soup. In boiling split peas some samples, without reference to variety, fall or moulder down freely into pulp, while others continue to maintain their form; the former are called boilers. This property of boiling depends on the soil. Stiff land, or sandy land, that has been limed or marled, uniformly produces peas that will not melt in boiling, no matter what the variety may be. Peas straw, cut green and dried, is reckoned as nourishing as hay, and is considered as excellent for sheep.

* Loudon.

The produce of peas in flour is as three to two of the bulk in grain, and husked and split for soups, as four to two. A thousand parts of pea flour afforded Sir H. Davy 574 parts of nutritive or soluble matter; that is, 501 of mucilage, 22 of sugar, 35 of gluten, and 16 of extract or insoluble matter.

Of field peas there are several varieties. The dark sorts are generally the longest in coming to maturity, and they have the rankest flavour. In favourable places, if they are sown in autumn, and cleared the instant they are ripe, they may be followed by turnips the same year; but if the sowing is delayed till after Christmas, the ground will not be free in time for any crop save winter wheat. A crop of peas is considered to improve the soil, especially for turnips. But it is not on the whole very profitable, unless upon very rich loams, in which situation they are often sown with beans, and the produce used as food for stock. The bean-stalks, from their greater strength, prevent the peas from lodging.

The ***Pisum Americanum*** is a biennial plant, which was found growing at Cape Horn by some of the people attached to Lord Anson's expedition. This fresh pulse was a most welcome addition to the ordinary sea provisions, and under such circumstances it appeared to be of more excellent flavour than the common pea. It was accordingly brought home and propagated; but was soon found not to equal even the worst sort of those which were already in cultivation, and it is now only preserved in botanical collections. The flowers are blue, each peduncle sustaining four or five flowers, the pods taper, and the seeds are very small.

The yellow flowering pea is found in a wild state in the corn-fields of Sicily and some parts of Italy; but is here merely preserved in botanic gardens for the sake of variety. The peduncles have but one flower each, and the pods and seeds are larger than those of the sea-pea. They are sometimes eaten; but they are coarse and of little value.

The Sea Pea (pisum maritimum). This plant is a native of Britain, is a perennial, and grows among loose stones by the sea shore. The seeds have a bitter and unpleasant taste; yet, according to Turner, in former times of scarcity they were used extensively as food.

The Bean *(vicia faba)*, has been cultivated in Britain from very remote antiquity, having been in all probability introduced into this country by the Romans. It is said to have originated in Egypt; perhaps because the Greeks, from whom we have the earliest accounts of it, received it from that country as a cultivated vegetable. Some travellers affirm that the bean is found growing wild in Persia, near the shores of the Caspian; but that part of Asia has been subjected to so many fluctuations, to so many alternations of culture and destruction, that it is not easy to decide whether any plants which may be discovered vegetating spontaneously be really indigenous, or only the remains of a former cultivation. In many parts of Britain, where all other memorials of former habitations and culture have been swept away, certain plants are found growing which a traveller passing hastily over the country would very naturally describe as indigenous, since of their introduction the present inhabitants of the vicinity could most probably give him no account, but which, from history and the nature of the plants themselves, are known to be exotics introduced at a specific time.

Beans are cultivated over many countries, as far to the eastward as China and Japan, and they are very generally used as an esculent in many parts of Africa. From its northern coast some of the more valuable varieties were transplanted by the Moors into Spain, and by the Portuguese into their own country.

This plant is grown abundantly in Barbary, where it is usually full-podded at the latter end of February, and continues in bearing during the whole of spring. When stewed with oil and garlic, beans form, according to Shaw, the principal food of persons of all classes.

The bean in its green state is well known as a culinary vegetable. When mature and dried it is never used as human food in this country; but is then considered good, though coarse, nourishment for labouring horses. Campbell, in his Political Survey, published in 1774, mentions, that "beans are exported for the food of the negroes in our plantations, and are employed in feeding horses at home; so that altogether they are in daily use, and most certainly turn to a very considerable amount." King stated the annual consumption of beans at that period to be four millions, and of peas seven millions of bushels. Campbell, indeed, considered this estimate to be excessive; but if it at all approximates to the truth, it shows that these legumes were then cultivated to a very great extent. Provisions for this unhappy race of human beings are in the present day somewhat better selected, and horse-beans do not any longer form an article of export to the colonies.

All the cultivated beans are annuals, having upright fibrous stems, rising from two to four feet high. The flowers are usually white, with a black spot in the middle of the wing; these are succeeded by long thick legumes, woolly within, and enclosing large flat seeds. These flowers are very fragrant; and the rich perfume of a bean-field, when the plants are in full blossom, is as familiar as it is delightful to all lovers of simple rural pleasures. The popular division of the several varieties is, like that of peas, into field beans and garden beans; the same va-

riety is, however, often cultivated in both situations. The earliest garden bean is a small seeded kind called the *mazagan.* The large variety, called the "Windsor bean," is said to have been first cultivated in that neighbourhood by some of the Dutch gardeners who came over at the revolution. There is a field near Eton still called "the Dutchman's garden."

Beans are propagated by seed sown in rows from two to three feet asunder, either by the dibble or by drilling; the early kinds in October, and from December to January inclusive. The main crop is sown in March and April, and the several varieties are continued in monthly succession until July. For late crops the seeds, previously to being used, are soaked for several hours in soft water. Some cultivators cut off the tops of the plants when in bloom, which operation is supposed to promote an earlier and more abundant production of well filled legumes; while a very late crop may be obtained by cutting down the plants, as soon as they are in flower, to within a few inches of the base. New stalks spring from the roots, and yield pods at an advanced period of the year.

The field bean, of which there is a larger and smaller sort, the latter called *ticks*, is sown in drills by a machine, so as to admit of horse-hoeing, and otherwise ploughing or stirring up between the rows. By this means a larger crop is produced, and the land cleaned and brought into a better state for a succeeding corn crop. Beans are excellent food for hard working horses, and for fattening hogs for bacon. The flour of beans and peas is more nutritive than that of oats, but less easy of digestion. A bushel of beans is supposed to yield fourteen pounds more of flour than a bushel of oats; and a bushel of peas eighteen pounds more, or, according to some, twenty pounds. A thousand parts of bean-flour were found by Sir H. Davy to yield 570 parts of nutritive matter, of which 426 were mucilage and starch, 103 gluten, and 41 extract.

The bean, though a coarser plant than the pea, is much more liable both to disease and to the depredations of insects. When the plants become sickly, from an unfavourable soil or season, small fungi are apt to form withinside the epidermis, such as the nestling spheria *(sphæria nidula)*, upon the roots, and the bean blight *(uredo fabæ)* upon the stems and leaves. Though these are most probably the consequence of a diseased state of the plants, they so destroy the epidermis as to render recovery impossible, and the crop is greatly injured or altogether destroyed. The black aphis also often commits terrible havoc. It generally appears first in the young leaves of the top, and therefore may be removed by a little timely care without injuring the plants; but if once it is allowed time to establish itself, it is very difficult of eradication.

Several other species of *vicia* are found growing wild in Britain, known as vetches or tares. Thus, *vicia sylvatica* and *v. cracca* are not unfrequent in meadows, and are considered as valuable herbage plants. They yield a great bulk of fodder, which is reckoned very nutritious. Some agriculturists have proposed to cultivate these alone; but Curtis remarks, that they would probably in that case choke themselves for want of support.

The Vicia Sativa, the winter and summer tare, is also a valuable agricultural plant. Some consider the winter variety as a distinct species; but Martyn proved, by cultivating both, that they were not even very distinct varieties. The winter variety is sown in September or October, and the summer at different periods from February to June, for successive cuttings. The soil requires to be in good condition, otherwise they will not grow to great luxuriance. On a good soil they will yield ten or twelve tons per acre. The crop is seldom left to ripen its seeds but when seeds are wanted. The only use of these is to feed pigeons or poultry.

The Kidney-Bean *(phaseolus)*, is so called from *phaselus*, a little boat, which the pods very much resemble. Two species are cultivated in England, both natives of warm countries, and though they grow and pod well in Britain during the warm months, they will neither bear the frosts of early spring, nor those of late autumn. The dwarf kidney-bean *(phaseolus vulgaris)*, a native of India, but erroneously called the French bean, is mentioned as being in common cultivation in England in the year 1597. The species called the *runner (phaseolus multiflorus)* was introduced from South America in the year 1633. It is supposed that the scarlet variety, which grows so tall and is so prolific, was first cultivated about that time by Tradescant, the celebrated gardener at Lambeth. It was then, we are told, in so great repute for its flowers, that they formed the leading ornament in the nosegays of the ladies; and it seems to have kept its place only as an ornamental plant for nearly a hundred years, as its legumes were seldom used as an edible substance until brought into notice by Miller of Chelsea, in the eighteenth century.

The general characteristics of the two species are the same. The leaves are ternate, attached to long petioles; and the flowers, differing in colour according to the variety, grow on racemes or short lateral branches, coming out from one common peduncle. These are succeeded by oblong pods, containing shining seeds of a kidney shape.

The stems are more or less voluble in all; but those of the dwarf kind are of very low growth, and require no support. The stalks of the runners ascend eight or ten feet, and, therefore, either tall sticks are provided around which they may

wind, or they are planted near a building or fence from which slender cords are suspended, and the flexile stems as they rise clasp and entwine themselves with these. "It deserves notice, that in their voluble habit of growth the tendrils turn to the right, or in a direction contrary to the apparent diurnal course of the sun. This aberration from the common habit of plants has been accounted for by supposing that the native climate of the scarlet runner will be found to lie south of the equator, and that the plant, although removed to the northern hemisphere, is still obedient to the course originally assigned to it, turning in a direction which in its native climate would be towards the sun." *

Both species are tender plants, and seldom thrive if they are sown very early in the season; but in favourable weather they are prolific bearers, especially the scarlet runner, which for a long continuance yields a plentiful crop from one sowing. Though generally supposed to be annuals, the runner is in fact a biennial, fresh shoots springing up from the root the second year.

In England, only the immature pod is used as a legume. The ripe seeds known by the name of *haricots* are prepared in various ways as a favourite edible in France, where the dwarf white kidney-bean is extensively cultivated as a field crop, to furnish a supply of their seeds, which are in so constant demand. The seeds of the Dutch runners, which are larger than these, and of a superior quality, are made into a kind of soup, which is held in much esteem in Holland. The leaves likewise of the kidney-bean afford when boiled a culinary vegetable which the Nubians consider an excellent esculent.

Some varieties of the kidney-bean are found in cultivation throughout almost every civilized country of the western as well as the eastern hemisphere. The small black beans called *fricollis*, which are in general demand all over Mexico, are no doubt a kind of kidney-bean. Recent travellers in that country relate that immense fields of these are under cultivation for the supply of the large cities, where they form a part of every meal, and are not only in great favour with the inhabitants, but are considered excellent even by strangers.

Another species, *the Snail Flower (phaseolus caracalla)*, so named from the Celtic *caracalla*, a hood or head dress, is a very curious plant, and will grow and flower freely if kept clear from the red spiders. This species was brought by the Portuguese from South America, and thus introduced into the gardens of Europe.

Among the productions of Bornou, Major Denham enumerates four kinds of beans, which are raised in great quantities, called *mussaqua*, *marya*, *kleeny*, and *kimmav*, all known by the general name of *gafooly*. These are eaten by the slaves and the poorer people. A paste compounded from beans and fish was the only eatable the Major and his companions could find in the towns near the river.

* Loud. Ency. of Gardening.

The Lentil *(ervum)*, is a small climbing plant, with weak stalks, about a foot and a half high. The leaves are winged, and each is terminated by a tendril. The flowers, of a pale purple colour, are succeeded by short flat pods, containing two or three flat round seeds. Another sort, distinguished as the French lentil, is of much larger growth than the former, and altogether more worthy of cultivation. These plants are rarely raised in England, and then only as food for cattle. In most parts of the continent they are cultivated for the use of man, and the seeds are made into soups, or become an ingredient in other culinary preparations. They are readily softened by, and mixed with, water, forming with it a pottage of a chocolate colour. In Catholic countries, where the formulary of the church enjoins a number of *meagre* days, such plants as the kidney-bean and the lentil are more cultivated than they are in countries where the religion of the people does not prescribe the same observances. In England there are no fasts scattered through the year on which the people are expected to subsist upon pulse with the addition of vegetable oils. The use of haricots and lentils is therefore but little known in this country.

The *Chick Pea, (cicer arietinum,)* is another small legume which is occasionally cultivated in the south of Europe, especially in Spain, where it is used as a dyeing ingredient as well as an article of food. It is known there, and on the opposite coast of the Mediterranean, by the name of *garavance* or *garvanzos*. These seeds do not, like most other pulse, become of a soft and pulpy consistence by boiling, and therefore they never constitute a dish by themselves, but are strewed singly as a garnish over certain savoury viands, and form part of the *olla*, a dish composed of bacon, cabbage, pumpkin, and garvanzos, with which a Spanish dinner almost invariably commences. The chick pea, when parched, has been much esteemed among many nations from the earliest periods of history, and in that state it still continues an article of great consumption. According to Bellonius, this pea was the parched pulse which formed the common provision of the Hebrews when they took the field; and Cassianus supposes it to have been the torrified seed mentioned by Plautus and Aristophanes. The *frictum cicer* seems also to have constituted a part of the usual food of the lower orders at Rome.

In those warm and arid countries where travellers are constrained to carry their scanty pro-

visions with them across vast desert tracts, they gladly supply themselves with small dried substances which require much mastication, and thus stimulate the salivary glands. Under these circumstances parched chick-peas, or *leblebby*, are in great demand, and are as common in the shops as biscuits in those of England. In Grand Cairo and Damascus there are many persons who make it their sole business to fry peas, for the supply of those who traverse the desert.

The seeds of the kerkedan, a small shrub found growing wild and sometimes cultivated in the north of Nubia, are made into a kind of bread, and form the principal food of the Kerrarish Arabs; and a decoction of the roasted grains is used as a substitute for coffee. Another shrub, called *symka*, indigenous to the same country, produces legumes resembling peas, and containing round rose-coloured seeds which afford excellent nourishment for camels, and are, when green, employed as human food. These likewise the "Arabs collect and dry, and by hard boiling obtain from them an oil which they use instead of butter to grease their hair and bodies."

Various descriptions of pulse are cultivated in the East, but these are seldom of a large growth. The culture of smaller legumes as human food, similarly with that of the millets and other small-seeded grains, is adapted only to that state of society in which the money-price of labour is low, and yet where the climate and other concurring circumstances are obstacles to the cultivation of the more valuable kinds of vegetables. Moisture and heat, as well as a soil comparatively rich, are required for the production of rice; and the cerealia grown in more temperate climates cannot be raised unless there be either a sufficiency of manure, which cannot be procured without an abundant stock of domesticated animals, or a natural richness of soil, which is incompatible with dry land in a warm climate.

In the elevated parts of India which lie out of the direction of the periodical rains, a scanty irrigation can at best be obtained, and that only by sinking deep wells, or by constructing tanks and reservoirs at a great expence; where these imperfect means are not within reach, the ground is scarcely ever moistened, as probably a shower of rain does not fall during six months. Under these circumstances the cultivation of pulse is resorted to as a matter of necessity, and the smaller and the more hardy these are, the more certain is the prospect of their yielding a crop. In sultry climates there is often a portion of humidity which plays in the atmosphere, and which will form dew upon the leaves of a plant, when the evaporative power of the naked and baked earth is so great that not a condensed drop will settle upon it, or a trace of moisture be found. From this cause dew may be seen early in the morning spangling the verdant lawn when there is no humidity whatever upon the gravel walk; and upon a burnt-up heath, any plant which may have preserved its greenness, will attract moisture, when the withered grass continues perfectly dry. The pulses which are sown in the rainless parts of India, not only preserve themselves, but often aid in preserving millet and other small grain with which they are mixed. When the Hindu, in his simple husbandry, sows several kinds of seed on the same land, he does not therefore give a proof of his ignorance of the art. There is in it a little of the schooling of experience, the practical knowledge of the climate with which he has to deal. He sows his small grain in order that he may have a good crop if the season should send him rain; and he at the same time sows pulse in order that he may not only reap pulse in the event of a drought, but that he may even then perhaps obtain with it a little accompanying grain.*

THE LUPINE, *(lupinus.)* The name of this well known plant is said to be derived from *lupus* (a wolf), because it devours, as it were, all the fertility of the soil; but this seems a very doubtful explanation. These plants, of which there are several species and varieties, are border flowers in much esteem in gardens for their velvet-like leaves and fine large flowers. They are vigorous growing plants, and if cultivated in the fields would afford the agriculturist a considerable bulk of herbage.

The white lupine is supposed to be the species that was cultivated for this purpose by the Romans, though the yellow species is what is grown in the fields in the present day in Italy, as human food. In the south of France the same plant is grown in the extensive plains of dry, poor soil of that country, as a meliorating crop, to be ploughed in where red manure is to be procured, and where clover or other herbage would not grow. The perennial and ligneous species may be increased by pieces of the root, but they all seed freely.

BITTER VETCH, *(orobus.)* This tribe, of which there are several species common in the fields of Britain, are easily known by their yellow and white papilionaceous blossoms.

The *orobus luteus* Haller considers as one of the handsomest of the papilionaceous family. *Orobus tuberosus*, according to Lightfoot, is in great esteem among the highlanders of Scotland for the tubercles of the root. They dry and chew them in general, to give a better relish to their liquor. They also affirm them to be good against most disorders of the chest, and that by their use they are enabled to repel hunger and thirst for a long time. In Breadalbane and Rosshire, they sometimes bruise and steep them in water,

* Library of Entertaining Knowledge.

and make an agreeable fermented liquor with them. They have a sweet taste, somewhat like the roots of liquorice, and when boiled are well flavoured and nutritive; and in times of scarcity have served as a substitute for better food. Boiled well a fork will pass through them, and dried slightly and roasted, they are served up in Holland and Flanders in the manner of chestnuts, which they resemble in flavour. Dickson recommends cultivating them in a bed or border of light, rich soil, paved at the depth of twenty inches, to prevent their roots from running down. Plant the tubers six inches apart, and three inches below the surface. The second year some will be fit to gather, and by taking only the largest, the bed will continue productive for several years, adding some fresh compost every year.

Lathyrus. Of this genus the chickling vetch, the sweet pea, everlasting pea, &c., are well known species.

The Chickling Vetch, *(l. sativus,)* is frequently cultivated on the continent. The straw is used for the stable, and a white, light, and pleasant-flavoured bread was made from the flower of the seed; but it produced such dreadful effects in the last century, that the use of it was forbid by the governments of the countries in which it was raised. Mixed with one half of wheaten flour, a perfectly harmless and good bread is produced; but when employed alone, and eaten for some time, the most singular rigidity of the muscles and paralysis of the limbs are brought on.

These symptoms usually appear on a sudden, and without any previous pain; but sometimes they were preceded by a weakness and disagreeable sensation about the knees. The cold and hot bath fomentations and stimulating ointments, were tried without effect by the people; the affection was regarded as incurable, and not being very painful or fatal, was endured by them with patience and unconcern.

Swine fed with this meal lost the use of their limbs, but grew very fat lying on the ground. A horse fed some months on the dry herb was said to have his legs perfectly rigid: cattle are reported to grow lean on it, but sheep are not affected. Pigeons, especially young ones, loose the power of walking by feeding on the seed. Poultry will not readily touch it, but geese eat it without any apparent damage. In some parts of Switzerland cattle feed on the herb without any harm. It becomes a question of some interest, then, whether the nature of the soil may not contribute to the deleterious qualities of the plant. It is remarked that the seed from a strong rich soil is much more deleterious than that from a light dry one.

Fabbroni, who wrote at Florence in 1786, says that the government there has cautioned the peasants against the use of this vetch, swine having lost the use of their limbs by being fed on it exclusively. The peasants, however, eat it boiled or mixed with wheat flour, in the quantity of one-fourth, without any harm.

The Sweet Pea, *(lathyrus odoratus,)* is one of the most esteemed of garden annuals. Its sweet scent, and the beauty of the flowers, rendering it a general favourite.

Saint-foin, *(hydesarum onobrychis.)* This is a deep rooting perennial, with branching, spreading stems, compound leaves, and showy red flowers. It is indigenous to many parts of Europe, and found exclusively on dry chalky soils, where it is of great duration. It has been long cultivated in France and in other parts of the continent, and as an agricultural plant a good deal in England in the chalky districts; and its peculiar value is, that it may be grown on soils unfit for being constantly under tillage, and which would yield little under-grass. This is owing to the long and descending roots of the saint-foin, which will penetrate and thrive in the fissures of rocky and chalky under-strata. Its herbage is said to be equally suited for pasturage or for hay; and eaten green it is not so apt to swell or hove cattle as the clovers or lucern.

Arthur Young says, that upon soils proper for this grass, no farmer can sow too much of it; for it is one of the most valuable herbage plants we owe to the bounty of Providence. The deeper the soil is stirred, previously to sowing, the better. The seed is generally put in broad-cast, at the rate of three or four bushels the acre; and sometimes a little red clover is sown afterwards to produce a crop the second season, when the saint-foin plants are but small. When saint-foin is annually mown, it should be top-dressed with manure; but if only occasionally mown, the benefits derived from the grazing of sheep or cattle will, to a considerable extent, answer for surface dressings in a plant that derives a part of its nutriment from the subsoil. Saint-foin is highly nutritive, either cut green or made into hay. The produce on a medium of soils and cultivation, may probably be estimated at from about one and a half to two tons the acre; and on the poorer and thinner staple sorts of land, it will perhaps seldom afford less than from a ton to a ton and a half on the acre. One thousand parts of saint-foin afforded Sir H. Davy thirty-nine of nutritive matter, which is the same as that afforded by the red and white clover. The usual duration of saint-foin in a profitable state, is from eight to ten years. It usually attains its perfect growth in about three years, and begins to decline towards the eighth or tenth on calcareous soils, and about the seventh and eighth on gravels. There are instances, however, of fields of this plant which had been neglected and left to run into pasture, in which

plants have been found upwards of fifty years from the time of sowing. It has been cultivated upwards of a century on the Cotswold hills, and three sorts of it have been traced down into stone quarries from ten to twenty feet in length; and in Germany, Von Thaer found them attain the length of sixteen feet. In general, the great enemy to the endurance of saint-foin is the grass which accumulates and forms a close turf on the surface, and thus chokes up the plant.*

Melilot, *(melilotus.)* The species of this family are similar to the lotus, and are the favourite resort of bees; hence the name from *mel*, honey, and *lotus*. The *m. officinalis*, is one of the plants which imparts the peculiar smell to hay. It is also employed, and forms the chief ingredient, in flavouring the Swiss cheeses called Gruyere. No doubt the milk, obtained by the pasturage formed of a mixture of various aromatic herbs, contributes to the peculiar excellency of these cheeses; but the flowers and seeds of the melilot, bruised and mixed with the curd, imparts an additional flavour.

Trefoil, or Clover, *(trifolium,)* literally a plant with three leaves. Two of the most valuable herbage plants, the red and white clover, are the most remarkable species of this genus.

"Notwithstanding," says Loudon, "all that has been said of the superiority of lucern to clover, and of the excellence of saint-foin, and other plants of the pea tribe, yet the red clover for mowing, and the white species for pasturage, are, and probably ever will, be found to excel all other plants in these respects. The yellow clover, *(t. procumbus,)* and the cow or meadow clover, *(t. medium,)* are also cultivated, but they are far inferior to the others. The meadow clover is a useful addition to the white sort, in laying down permanent pastures. The yellow grows on poor soils, but the herbage is not much liked by cattle. The soil best adapted for clover is a deep sandy loam, which is favourable to its long tap roots; but it will grow in any soil provided it be dry. So congenial is calcareous matter to clovers, that the mere strewing of lime on some soils, will call into action clover seeds, which, it would appear, have lain dormant for ages. At least this appears the most obvious way of accounting for the well known appearance of white clover in such cases. The climate most suitable for the clovers, as of most plants natives of Europe, is one neither very hot, nor very cold and dry. Most leguminous plants delight both in a dry soil and climate, and warm temperature; and the clover will be found to produce most seed under such circumstances; but as the production of seed is only in some situations an object of the farmer's attention, a season rather moist, provided it be warm, is always attended by the most bulky crops of clover herbage. The time of sowing seeds is generally the spring, during the corn seed time, or from February to May, but they may be also sown from August till October; and when they are sown by themselves, that is, unaccompanied by any corn crop, this will be found the best season, as the young plants are less liable to be dried up and impeded in their progress by the sun than when alone in spring, and remaining tender and unshaded during the hot and dry weather of July. The manner of sowing is almost always broad-cast. When sown with spring corn, clover and grass seeds are usually put in immediately after the land has been pulverized by harrowing in the corn seed, and are themselves covered by one course more of the harrows; or if the corn is drilled, the small seeds are sown immediately before or after hand hoeing, and the land is then finished by a course of the harrows. The quantity of seed varies from eight to fourteen pounds per acre, according to the intention of the crop, and the quantity of grass seeds sown along with the clover.

The clover and rye grass crop is either cut green or made into hay, or fed upon by cattle. The produce of clover hay, without any mixture of rye grass, on the best soils, is from two to three tons per acre; and in this state, in the London market, it generally sells 20 per cent. higher than meadow hay, or clover and rye grass mixed.

The produce in seed may generally be from three to four and five bushels per acre, weighing from two to three hundred weight.

Tree Medick, *(medicago arborea.)* This shrub is supposed to be the *citysus* of the ancients. It flowers the greater part of the year, beginning in April, and continuing till December, and with its delicate stem and handsome leaves, forms a conspicuous ornament in the shrubbery. It grows in great plenty in Abruzza, and other parts of the kingdom of Naples, where the goats feed on it, and their milk yields abundance of cheese.

It seems to be the shrub alluded to by Virgil and Columella as the citysus. In this country, however, it has not been found useful as an article of food for animals; and, indeed, will not grow luxuriantly except in gardens and warm shrubbery ground.

Lucern, *(medicago sativa,)* is a deep rooting perennial plant, sending up numerous small and clover-like shoots, with blue or violet spikes of flowers. It is highly praised by the Roman writers, and is also of great antiquity in Old Spain, Italy, and the south of France; and is much cultivated in Persia and Peru, where it is mown all the year round.

In Britain it excited little attention till Harte brought it into notice in 1757, and though much extolled, has not yet found great reception in

* Loudon.

this country. It is less hardy than red clover, requiring three or four years before it attains its full growth, thus becoming less adapted for profitable cropping in the rotations of English farming.

The yellow or Swiss lucern *(m. falcata)*, is a coarser and much more hardy plant than the other. The soil suited for the growth of lucern should be dry and friable, and rather sandy, but good and deep. The climate requires to be warm and dry. The seed should be sown early in the spring months. From fifteen to twenty pounds per acre of broad-cast, is the quantity usually required.

The mowing, &c. of this plant is the same as that used for clover. According to Sir H. Davy, the nutritive qualities of the plant are two and three tenths per cent.; and are to that of the clovers and saint-foin as twenty-three to thirty-nine.

Hop Trefoil, *(medicago lupulina,)* is by some considered the *shamrock* of the Irish. It very nearly resembles the common yellow clover, but is larger than that plant, and is a perennial, while the clover is an annual.

Liquorice *(Glycyrhiza glabra)*. This is a perennial deep-rooted plant, with herbaceous stalks, four to five feet in height, pinnated alternate leaves, and small blue, violet, white, or purplish papilionaceous flowers, disposed in axillary heads or spikes. It belongs to the natural order *Leguminosæ*, and to the class *diadelphia*, and order *decandria* of Linnæus.

118.

Liquorice.

Liquorice is a native of the south of Europe, and appears to have been cultivated in England since the time of Elizabeth. The chief places where it was long reared in any quantity for sale, were Pontefract in Yorkshire, Worksop in Nottinghamshire, and Godalming in Surrey. It is now, however, raised by many gardeners in the vicinity of London, by which the London market is supplied with roots in no respect inferior to those of warmer climates.

It requires a deep sandy loam, trenched by the spade or plough to two or three feet deep, and manured if necessary. The plants are procured from old plantations, and consist of those side roots which have eyes or buds. The planting season is either October or February, and March; the latter is preferable. The plants are dibbled in, in rows three feet apart. The plants do not rise above a foot the first season, and take three years before the root is fit for use.

Decoctions of this root yield an extract containing a large quantity of saccharine matter and mucilage, with a little bitter extract. It is used in medicine under various forms, and is the black sugar, or Spanish juice, so generally known. The liquorice roots are also used by brewers, to a considerable extent, in the manufacture of porter.

Liquorice juice has been famed since the days of Hippocrates as useful in allaying thirst. Dr Cullen supposes, however, that this property does not actually belong to the saccharine juice; but that if a piece of the root be chewed till all this juice is extracted, there remains a bitter which acts on the salivary glands, and this may contribute to remove thirst.

Chestnut Bean *(castanospermum Australe)*. This bean was discovered by Mr Cunningham upon the banks of the river Brisbane, which flows into Morton bay, New South Wales. It grows on a large handsome tree, which belongs to a new and undescribed genus, in many particulars allied to the *robinia*. The leaves are pinnated on long footstalks, the leaflets entire, with a terminal one. The flowers, which are papilionaceous, are produced at the bases of the leaves in considerable numbers, not unlike those of the *robinia hispida*. Those flowers are succeeded by large hard pods, of a brown cinnamon colour. The pods contain a varying number of round seeds, or beans, compressed on one side, and covered with a thin loose shell of a chestnut colour. When these beans are roasted they have much the flavour of chestnuts, and may yet prove in that country a wholesome article of food.

Though not belonging to the family of pulses, the following plant may here be described as intermediate between this family and the gramineæ.

Buck-wheat *(polygonum fagopyrum)*, or beech wheat, from its seed resembling the mast of beech. *Octandria, trigynia*, Linn.; nat. order, *polygoneæ*. Buck-wheat is considered a native of Asia, though sometimes found in Europe in a seemingly wild state. It will not, however, bear the frosts of our springs, or the severity of winter. In China and other eastern countries it is cultivated as a bread-corn. The meat of the seed is also used in cooking, and in making a kind of coarse bread, in various parts of Europe.

Buck-wheat is an annual plant, growing rather handsome, with branched herbaceous stems, having leaves which at first are roundish, but afterwards become arrow-shaped, resembling some-

what those of ivy, but being longer pointed and much softer. The stalk is round and hollow; its general colour is green, but it sometimes has a reddish tinge. It commonly grows to the height of about thirty inches. At almost every joint of the stalk, lateral branches shoot out, which are terminated by purplish flowers, and these are succeeded by small triangular-shaped seeds, which are of a brownish-black colour on the outside, and white within. This grain is usually sown in May or June, and is of such rapid growth, that it generally ripens its seeds within about one hundred days from the time of sowing. It will thrive in any soil, even in those which contain little else than sand. The largest increase is, however, obtained from dry ground, which has been thoroughly ploughed and pulverized; and in such circumstances, as much as fifty or sixty bushels have been reaped from an acre, on which only one bushel of seed has been bestowed.

This plant is more generally cultivated for the sake of its green fodder, and then the seed is strewn much thicker, as much as three or four bushels being allotted to the acre. If the season is forward, and the weather continues warm, buck-wheat may be sown for this purpose in April, and will bear cutting twice during the summer; but the slightest degree of frost will destroy it entirely. When it is thus intended to apply the plant as green meat, a sufficient quantity should be cut one day for the consumption of the next. The state most proper for cutting is when the blossoms are making their appearance.

All animals are fond of this food, and will thrive upon it. When given to cows it causes them to yield an abundance of excellent milk, which makes good butter and cheese. The stalk and leaves will continue green during the driest weather, even when all the grasses in the meadows are burnt up. The straw or haulm is sometimes given in a dry state to cattle, but is not then so useful as when green.

Buck-wheat is also sometimes sown in order that the plants may be ploughed into the ground, and serve as manure in the process of bringing lands into proper order for other crops. The time most proper for this ploughing is when the blossoms are full upon the plants, as they are then in their most succulent state. The land is then left at rest for some months, during which time the vegetable matter of the buck-wheat becomes fermented and decomposed. The variety known as Tartarian buck-wheat, *polygonum tartaricum*, being of more luxuriant growth than the common sort, *fagopyrum*, has been preferably recommended for this object.

Birds are exceedingly fond of the seeds, and one of the principal uses made of them in this country is to feed pheasants during the winter, in spots set apart for the preservation of that species of game. With this object, the grain is sometimes sown in these preserves, and left standing, to afford both cover and food to the birds; at other times the straw is taken unthreshed, and left in heaps at intervals throughout the places where the birds resort. Such an abundance of their favourite food will not only prevent pheasants from rambling, but frequently allures others from spots where an equally comfortable provision is not made.

Horses are fond of the seeds, which are sometimes given to them in conjunction with oats; it is proper, however, in such case, to subject the buck-wheat to the previous operation of crushing. Pigs are often fattened upon buck-wheat; and it is said, that if this food be given to them in great quantity at first, it will occasion the animals to exhibit symptoms of intoxication, so that they run squeaking and tumbling about in a grotesque manner. As they become habituated to the use of the grain, such an effect ceases. It is necessary to crush the seeds for this purpose also.

Buck-wheat is sometimes used by distillers, it being capable of yielding a considerable quantity of good spirit. This use is made of it to a great extent at Dantzig, where an extensive manufacture of cordial waters is continually carried on.

The poor of some countries mix the meal of buck-wheat with a small proportion of wheat-flour, and make a kind of bread of the compound, which is black and bitter, and deficient in a due degree of nourishment. In Brabant it is not unusual for persons who derive a profit from keeping bees to sow this grain near to their dwellings, they being of opinion that no plant is equal to it for affording to those insects a proper supply of materials whence their sweet store is elaborated.

CHAP. XXXIV.

ROSACEÆ—THE APPLE, PEAR, QUINCE, PLUMB, PEACH, CHERRY, STRAWBERRY, RASPBERRY, &c.

The natural family rosaceæ embraces a considerable number of plants of the herbaceous kind, shrubs, and trees. It takes its name from the rose, which may be considered as the type of the family. Besides this, the chief of ornamental flowers, it comprehends other favourites of the garden, as the potentillas, geums, &c. This family also includes all the most important fruits of the temperate regions. Thus, to the genera *pyrus*, belong the apple and pear; to *prunus*, the plumb and apricot; to *amygdalus*, the peach, nectarine, and almond; *criobotrya*, the loquat; *mesphilus*, the medlar; *cydonia*, the quince;

while *fragraria* contains the strawberry, raspberry, and bramble.

The medicinal properties of many plants of this family are not less active than their fruits are excellent. The principal of these is the well known prussic acid, which exists in abundance in the leaves and kernels of many genera, especially in *prunus* and *amygdalus*. It is the active ingredient in laurel water, which, when taken in small doses, acts either as an emetic or violent purgative, and in larger doses, proves almost instantly fatal by at once destroying the irritability of animal fibre without any organic change of structure, such as inflammation. Some of the other genera, as the *drupaceæ*, yield a gum, similar to gum Arabic; and this shows the near affinity of the two families of *leguminosæ* and *rosaceæ*. Others yield an astringent principle, and are employed in medicine and the arts. The root of the tormentilla was formerly used in Scotland for tanning leather, and is still so used in the Ferro islands; while that of the capollim cherry is similarly employed in Mexico. The bark of *prunus Virginiana* is used as a febrifuge in the United States of America; and that of *potentilla reptans* has been praised for the same properties. The root of *geum urbanum* has been found, by Milandi and Moretti, to contain one-eleventh of its weight of tannin. It has been used both in America and Europe as a substitute for Peruvian bark. The leaves of *dryas octopetala* in the north of Europe, of *rubus arcticus* in Norway, of *prunus spinosa* and *avium*, and of *rosa rubiginosa*, have been dried and used as a sort of substitute for tea. The bark of the root of *gallenia trifoliata* is remarkable in having, in addition to the astringency already mentioned, an emetic property, on which account it is employed in North America in place of ipecacuanha. It is said that a similar power exists in other *spiræi*. The family *rosaceæ* nearly corresponds to the class *icosandria* of Linnæus. The leaves are alternate, simple, or compound, accompanied at the base by two persistent stipules, sometimes united to the petiole. The calyx is monopetalous, with four or five divisions; the corolla consists generally of four or five regularly spreading and delicate petals; the stamina are generally very numerous and distinct; the pistil is formed of one or several carpels, either free and distinct, or adherent by their outer sides to the calyx; sometimes they are also united to each other, or collected into a kind of capitulum upon a receptacle; the style is always more or less lateral, and the stigma simple. The form and position of the fruit is extremely diversified.

We proceed to consider the fruit-bearing trees and plants of this family, and shall commence with the apple.

The Apple *(pyrus malus)*. The English name of this well known fruit is said to be derived from the Greek *apιος*, and the Celtic *api*, both signifying a fruit. The apple is essentially a fruit of the colder and more temperate regions of the globe, over which it is almost universally spread and cultivated. The tree attains a moderate height, with spreading branches; the leaf ovate, and the flowers, terminating in umbels, are produced from the wood of the former year, but more generally from very short shoots or spurs, from wood of two years' growth. The fruit is roundish, umbilical at the base, and of an acid flavour. The original of the cultivated apple is the wild crab, which is armed with spines or thorns, has serrate leaves, and a small extremely acrid fruit, and is to be found as an indigenous tree in most of the countries of Europe. From the crab all the numerous varieties of the apple, which are cultivated so extensively in most parts of Europe and in North America, have been derived. The apple tree is supposed by some to attain a great age. Haller mentions some trees in Herefordshire that attained a thousand years, and were highly prolific; but Knight considers two hundred years as the ordinary duration of a healthy tree, grafted on a crab stock, and planted in a strong tenacious soil. Speichly mentions a tree in an orchard at Burton-joyce, near Nottingham, of about sixty years old, with branches extending from seven to nine yards round the bole, which in 1792 produced upwards of a hundred pecks of apples. Of all the different fruits of the colder latitudes, the apple is perhaps the most serviceable. It is of easy culture, remains the longest in season, is used in the greatest number of ways, and is universally relished. The stone fruits of the British orchard keep only for a few days, unless they are preserved, and in this state they lose that natural flavour on which their value chiefly depends. Many of the finer pears keep only for a short time, when they ferment and become vapid; while there are apples of very rich flavour, which, with care, can be preserved from one fruit season till the commencement of another.

The celebrated traveller Von Buch has remarked, that the apple and the commoner fruit trees grow in the open air wherever oaks thrive; accordingly we find the apple cultivated to the sixtieth degree of north latitude. Even in the Orkney and Shetland islands very good apples grow. As we proceed farther north the apple is scarcely known. The people of Lapland showed Linnæus what they called an apple tree, which, they said, bore no fruit, because it had been cursed by a beggar woman, to whom the owner of the tree had refused some of its produce. The naturalist found that it was the common elm, a tree also rare in that severe climate. The apple, as well as most other European fruits, which now appear indigenous, is probably a native of

the East. The prophet Joel, enumerating the trees of Syria, says, "the vine is dried up, and the fig tree languisheth; the pomegranate tree, the palm tree also, and the apple tree, even all the trees of the field are withered." The cultivated apple was probably scarce at Rome in the time of Pliny; for he states that there were some apple trees in the villages near the city which yielded more profit than a small farm. The art of grafting was at that period either very recently discovered, or comparatively little known. This practice must evidently have belonged to an advanced state of civilization. It is remarkable that Moses, in his directions to the Israelites when they "shall come into the land, and shall have planted all manner of trees for food," makes no mention of the art of grafting. Hesiod and Homer, in like manner, have no allusion to a practice which would naturally have formed part of their subject had it existed when they wrote. The art of grafting, as well as that of pruning, has been ascribed to an accidental origin. The more vigorous shooting of a vine, after a goat had broused on it, is said to have suggested the one great principle in the management of fruit trees; and it is probable that the occasional natural union of the boughs of distinct trees may have shown the general practicability of the other. Pliny mentions apple trees "that will honour the first grafters for ever;" and this enthusiastic sort of praise belongs to the infancy of an art, when mankind are first conscious of its blessings, and therefore not disposed to undervalue them through their familiarity. To the facility of multiplying varieties by grafting, is to be ascribed the amazing extension of the sorts of apple, probably from one common stock. The varieties at present known are considerably more than a thousand. Of late years these varieties have increased in a remarkable manner, by the application of the pollen of one sort to the blossom of another.

Many of the better sorts of English apples were probably at first introduced into this country from the continent. The greater part of our names of apples are French, either pure or corrupted. Those varieties which had been celebrated abroad were spread through the kingdom by their cultivation in the gardens of the religious houses; and many of these fine old sorts still exist. Thus the *nonpareil*, according to the old herbalists, was brought from France by a Jesuit, in the time of queen Mary, and first planted in the gardens of Oxfordshire. The *oslin*, or *Arbroath pippin*, an ancient Scotch variety, was either introduced or extensively cultivated by the monks of the abbey of Aberbrothwick. On the other hand, the celebrated *golden pippin* has been considered as the native growth of England, and noticed as such by French and Dutch writers. It is described by Duhamel under the name of *pomme d'or*, *reinette d'Angleterre*. The same celebrated authority on fruit trees, also mentions the *grosse reinette d'Angleterre*. The more delicate apples for the table, such as the pippins, were probably very little known here till the latter part of the sixteenth century. Fuller states that one Leonard Maschal, in the sixteenth year of the reign of Henry VIII., brought pippins from over sea, and planted them at Plumstead in Sussex. Pippins are so called because the trees were raised from the pips or seeds, and bore the apples which gave them celebrity without grafting. In the thirty-seventh year of the same king we find the barking of apple trees declared a felony; and the passing of the law had probably a relation to the more extended growth of the fruit through the introduction of pippins. "Costard-monger" is an old English term for the dealers in vegetables, derived from their principal commodity of apples; the costard being a large apple, round and bulky as the head, or "costard." If we may deduce any meaning from this name, which is the same as "coster," it would appear that the costard, or large apple, was the sort in common use, and that hence the name of the variety became synonymous with that of the species; the more delicate sorts were luxuries unknown to the ordinary consumers of our native fruits, till they were rendered common by the planting of orchards in Kent, Sussex, and other parts of the kingdom.

The growth of the more esteemed apple trees had made such a general progress in half a century, that we find Shakspeare putting these words in the mouth of Justice Shallow, in his invitation to Falstaff: "You shall see mine orchard, where, in an arbour, we will eat a last year's pippin of my own graffing." Sir Hugh Evans, in the "Merry Wives of Windsor," says, "I will make an end of my dinner—there's pippins and cheese to come." Pippins were, therefore, in the time of Shakspeare, delicacies for the dessert. But in another fifty years the national industry had rendered the produce of the apple an important article of general consumption. The fine cider orchards of Herefordshire began to be planted in the reign of Charles I. The adaptation of these apples to the soil was quickly discovered, and they spread over the face of the whole country. Of the varieties of the cider apples, the *redstreak* and the *sline* were formerly the most prized; and the cider of these apples, and the perry of the *squash* pear, were celebrated throughout Europe. At the time when cider was first manufactured in England, it was believed that it would almost wholly supersede the use of foreign wines. From the period of the Norman conquest England carried on a great wine trade with France, principally with Bordeaux and the neighbouring provinces. It

increased considerably when Henry II. married the daughter of the duke of Aquitaine; and after the kings of England subsequently became possessed of some of the great wine provinces of France, the consumption of their produce was almost universal. About the middle of the sixteenth century, although no wines were permitted to exceed the price of twelve-pence per gallon, we find a law enacted, by which no person, except those who could expend a hundred marks annually, or were of noble birth, should keep in his house any vessel of wine exceeding ten gallons—a regulation which would suggest that the demand for wine was greater than the supply, owing probably to the increase of the middle ranks of society. In the year 1635, we find a patent granted to Francis Chamberlayne, for making wine from the dried grapes of Spain and Portugal; and the patentee set forth that his wines would keep good during several years, and even in a voyage under the line.

Cider became a general beverage before the time of Charles II., though it had been partially used for nearly a century before. Gerard, who published his Herball about the close of Elizabeth's reign, says, in his quaint way, "I have seen, about the pastures and hedgerows of a worshipful gentleman's dwelling, two miles from Hereford, called Mr Roger Badnome, so many trees of all sortes, that the servants drink, for the most part, no other drink but that which is made of apples. The qualitie is such, that, by the report of the gentleman himselfe, the parson hath for tythe many hogsheads of cyder."

We have already alluded to the great number of varieties of the apple. These have gone on increasing with the increased zeal and industry of modern gardeners. In 1573 Tusser mentions, in his list of fruits, "apples of all sorts." Parkinson, in 1629, enumerates fifty-seven sorts. Evelyn, about thirty years afterwards, says, "It was through the plain industry of one Harris, a fruiterer to Henry VIII., that the fields and environs of about thirty towns in Kent only were planted with fruit from Flanders, to the universal benefit and general improvement of the country. In 1650, Hartlib speaks of "one who had two hundred sorts of apples," and "verily believes there are nearly five hundred sorts in this island." Ray, in 1688, selected from the information of the most skilful gardeners about London a list of seventy-eight sorts. Succeeding writers have been enabled greatly to increase the list, partly from the almost continual accession of sorts received from the continent during intervals of peace, but principally from the great number reared from seeds. The second edition of the Catalogue of Fruits, published by the horticultural society of London in 1831, contains the names of 1400 sorts of apples; and although some of these may, when fruited, prove synonymous, yet the accession of new collections within the seasons of 1832 and 1833, would doubtless extend the number of distinct sorts beyond 1500.

A variety of the apple, like that of most other plants, is supposed by some to have only a limited duration; and hence, on looking back on the lists of Parkinson, Evelyn, and other authors, many of the varieties then numbered are not now to be found, or are so degenerated or diseased as no longer to deserve the attention of the planter. Thus the *moil*, and its successful rival the *redstreak*, with the *musts* and *golden pippin*, are in the last stage of decay, and the *stine* and *fox whelp* are hastening rapidly after them. This circumstance has given rise to a curious physiological speculation. Mr Knight, after studying the subject, and making a great variety of experiments for several years, and attempts to propagate every old variety, arrives at the following result: "I think," says he, "I am justified in the conclusion, that all plants of this species, however propagated, from the same stock, partake in some degree of the same life, and will attend the progress of that life in the habits of its youth, its maturity, and its decay, though they will not be any way affected by any incidental injuries the parent tree may sustain after they are detached from it." This rather fanciful opinion has not been confirmed by other horticulturists; on the contrary, several eminent writers consider that the deterioration of the varieties of the apple and other fruits may be owing to climate, and that the return of genial summers would restore to us from old trees as good fruit as heretofore. Loudon remarks on this subject: "It is unquestionably true that all varieties have a tendency to degenerate into the primitive character of the species; but to us it appears equally true, that any variety may be perpetuated with all its excellencies by proper culture, and more especially varieties of trees. However unsuccessful Knight may have been in continuing the *moil*, *redstreak*, and *golden pippin*, we cannot alter our conviction, that by grafting from these sorts they may be continued, such as they are or were when the scions were taken from the trees, to the end of time. As to plants propagated by extension, 'partaking in some degree of the same period of life as the parent,' we cannot admit the idea as at all probable. Vines, olives, poplars, and willows, have been propagated by extension for ages, and are still, as far as can be ascertained, as vigorous as they were in the time of Noah or Pliny." *

In enumerating a few of the most approved varieties of the apple, we shall class them as they are suited for the dessert, for the kitchen, for cider making, or for cottage economy.

* Ency. of Gardening.

For the Table. Apples for the table are characterised by a firm juicy pulp, poignant flavour, regular form, and beautiful colouring, as the sugar-loaf pippin, Wormsley pippin, autumn pearmain, king of the pippins, Fearn's pippin, Ribston pippin, old pome, rosy Hertfordshire pearmain, Pennington's seedling, Rennet du Canada, Dutch mignonne, Sweeny nonpariel, Dowton nonpariel, Newton pippin, Boston russet.

For the Kitchen. Apples for cooking are characterised by the property of what is technically called *falling*, or forming by the aid of heat, into a general pulpy mass of equal consistency, as also by their large size, and keeping properties. Some have this property of falling when green, as the Keswick, Carlisle, and Hawthornden codlins; others, again, only after they are ripe, as the russet tribe. The following may suit either for dessert or kitchen use. Gravenstein and Blenheim pippin, Bedfordshire foundling, Brabant bellefleur, London pippin, white winter calville, northern greening, Rhode island greening.

For Cider. For the purpose of making into cider, the apples must have a considerable degree of astringency, with or without firmness of pulp or richness of juice. The best kinds, according to Knight, are often tough, dry, and fibrous; and the Siberian harrey, which he recommends as one of the very best cider apples, is unfit either for culinary purposes or the table. Knight remarked that the specific gravity of the juice of the apples was a test of the future strength of the cider to be made from them.

For Cottage Gardens. Where the space will admit of only one tree, the best is the Ribston pippin; if two, add to this the Dutch mignonne; if three, add to these the Wormsley pippin; and, according to space and convenience, king of the pippins, old nonpariel, Dowton nonpariel, alfriston, Bedfordshire foundling, Pennington's seedling. For training against the wall or roof, the best are the Ribston pippin, old nonpariel; or when a large kitchen apple is required, the Bedfordshire foundling, the Hawthornden, or nonsuch. In cold and unfavourable situations, the court pender plat, the Bedfordshire foundling, the northern greening, or the Keswick codling, which is an excellent autumn apple for kitchen use. Unlike other fruits, the apples which ripen latest are the best. The trees may be transplanted at various ages, apple trees bearing this process at a greater age than any others. The time of transplanting may be in any open weather, from November till February.

The propagation of apple trees is accomplished by seeds, cuttings, suckers, layers, or ingrafting. In raising from seed, care should be taken in the choice of the fruit and varieties. The sorts of apples proper for crossing, or reciprocal impregnation, appear to be those which have a great many qualities in common, and some different qualities. Thus, the golden pippin has been crossed by other pippins or rennets, and not by calvils or codlings. A small sized apple crossed by a large sort, will be more certain of producing a new variety than the above mode, but will be almost equally certain of producing a variety destitute of valuable qualities, the qualities of parents of so opposite a nature, being, as it were, crudely jumbled together in the offspring. Mr Knight's method was as follows. In the blossoms of the variety to be impregnated, he cut out the stamens early; and after the pistil was mature and ready for the pollen, he introduced this from stamens of another variety. In this way, by impregnating the orange pippin with the pollen of the golden pippin, he produced the dowton, red and yellow ingestrie, and grange pippins.

The seeds may be sown in autumn in light earth, covered an inch, and either in beds or in pots. They should be transplanted out at the end of the first year. The quickest way to bring them to a bearing state, according to Williams, is to let the plants be furnished with lateral shoots from the ground upwards, so disposed as that the leaves of the upper shoots may not shade those situated underneath, pruning away only trifling shoots. In this way he procured fruit from seedling apples at four and five years of age, instead of waiting ten years, as in ordinary cases.

By *cuttings*, every variety of apples may be propagated. Trees raised in this way, according to Bigg, from healthy one year old branches, with blossom buds upon them, will continue to go on bearing the finest fruit in a small compass for many years; and are not liable to canker, probably because they spread out their roots horizontally, and do not send down a long tap root. The cuttings are to be chosen from the young wood of horizontal or oblique branches, from six to eight inches or more in length, with a small portion of old wood at the lower end. The tip of the shoot is to be cut off, and all their buds, except two or three next the tip; the section at the lower end is then to be smoothed, and the twig inserted three or four inches in sandy loam, covering with a glass, and watering and shading them. The proper time for this operation is early in February.

Grafting and *Inoculation.* This may be said to be the universal practice in propagating the apple. There are five kinds of stocks on which the graft may be inserted. *Seedling apples* used for full standards, and riders or wall standards. *Seedling crabs*, for standards or half standards; *codling apples*, from layers or cuttings, for dwarfs and espaliers; *paradise apples* or *doucins*, from layers or cuttings, for low dwarfs trained; and *creeper apples*, from layers or cuttings, for the best dwarfs or bushes.

A preference, says Knight, has generally and justly been given to apple stocks raised from the seeds of crabs or the native tree, as being more hardy and durable, than those produced from apple seedlings. The offspring of some varieties of the crab, particularly that introduced from Siberia, vegetate much earlier in the spring, and hasten on to maturation sooner in summer than other species of more temperate climes; and hence it was at first supposed that such stocks would continue to accelerate the grafts put on them in a similar manner; this, however, is found not to be the case, the stock being entirely subservient to the influence of the branches. The operation of ingrafting we shall describe afterwards.

The apple tree thrives best in a rich deep loam, or marshy clay; but it will thrive in any soil provided it is not too wet or too dry. It succeeds best in situations which are neither high nor remarkable low; in the former its blossoms are frequently injured by cold winds; and in the latter by spring frosts, particularly when planted in the lowest part of a confined valley. A south or south-east aspect is generally preferred, on account of the turbulence of the west, and the coldness of north winds; but orchards, where mutual shelter is afforded, succeed well in all aspects.

In all the varieties of the apple, the mode of bearing is upon small terminal and lateral spines, or short robust shoots, from half an inch to two inches long, which spring from the younger branches of two or more years' growth; appearing first at the extremity, and extending gradually down the side; the same bearing branches and fruit spines continue many years fruitful.

Pruning. Apple trees do not admit of shortening in the general bearers, except when any grow out of order, or irregularly, when they may be pruned. As, where a good shoot is contiguous to a vacant space, it may be shortened to a few eyes, in order that it may bud out luxuriantly, and fill the vacant space. But to shorten without such motives is not only to cut away the principal bearing part of the branches, but gives encouragement to the putting forth of many useless woody shoots, where fruit spines would otherwise arise. Espaliers and wall trees require more cutting both in summer and winter, as well as training into particular positions. All the best fruit spines are carefully retained, and the loose and useless shoots lopped off.

Apple trees are very liable to injuries by insects. The greatest enemy is the apple bug, or wooly aphis, *(aphis lanigera.)* This insect first appeared in a nursery in Sloan St London, so recently as the year 1787, and has now spread over the whole kingdom. It is a minute insect, covered with a long cotton-like down, and lives in the chinks of the bark, where it multiplies rapidly. It may be destroyed by anointing the trees with spirit of tar, or carefully freeing the branches of all loose bark, and sponging them with lime water. In early spring the blossom is attacked by the caterpillar of two or three small moths, which conceal themselves in the buds and open leaves, thus causing what is called the *blight.* When the leaves are fully expanded, other caterpillars attack and feed on them, the chief of which is the figure of eight moths, *(bombyx cœvaleocephalus;)* snails and slugs also, as well as the larvæ of insects, prey upon the tender fruit.

In several of the counties of England, cider is largely manufactured from apples. This process consists in grinding down the pulp in a mill, collecting and afterwards fermenting the juice, when a brisk, pleasing, acid liquor is produced.

The cider counties of England have always been considered as highly interesting. They lie something in the form of a horse-shoe round the Bristol channel; and the best are, Worcester and Hereford on the north of the channel, and Somerset and Devon on the south. In appearance, they have a considerable advantage over those counties in which grain alone is cultivated. The blossoms cover an extensive district with a profusion of flowers in the spring, and the fruit is beautiful in autumn. Some of the orchards occupy a space of forty or fifty acres; and the trees being at considerable intervals, the land is also kept in tillage. A great deal of practical acquaintance with the qualities of soil is required in the culture of apple and pear trees; and his skill in the adaptation of trees to their situation principally determines the success of the manufacturer of cider and perry. The produce of the orchards is very fluctuating; and the growers seldom expect an abundant crop more than once in three years. The quantity of apples required to make a hogshead of cider is from twenty-four to thirty bushels; and in a good year an acre of orchard will produce somewhere about six hundred bushels, or from twenty to twenty-five hogsheads. The cider harvest is in September. When the season is favourable, the heaps of apples collected at the presses are immense, consisting of hundreds of tons. If any of the vessels used in the manufacture of cider are of lead, the beverage is not wholesome. The price of a hogshead of cider generally varies from £2 to £5, according to the season and quality; but cider of the finest growth has sometimes been sold as high as £20 the hogshead, direct from the press, a price equal to that of many of the fine wines of the Rhine or the Garonne.

The Pear, *(pyrus communis.)* This tree, in its wild state, is armed with thorns, has upright branches tending to the pyramidal form, in which it differs materially from the apple tree. The twigs or spray hang down, the leaves are ellipti-

cal, obtuse, serrate; the flowers in terminating villose corymbs produced from wood of the preceding year, or from buds gradually formed on that of several years' growth on the extremities of very short protruding shoots, technically called spurs. It is found in a wild state in England, and abundantly in France and Germany, as well as other parts of Europe, not excepting Russia, as far north as latitude 57°. It grows in almost any soil. The cultivated tree differs from the apple not only in having a tendency to the pyramidal form, but also in being more apt to send out tap roots, in being, as a seedling plant, longer of coming to bearing, taking from fifteen to sixteen years; and when on its own root, or grafted on a wild pear stock, of being much longer lived. In a dry soil it will exist for centuries, and still keep its health, productiveness, and vigour. The pear has been known from the remotest antiquity.

Amongst the trees which Homer describes as forming the orchard of Laertes, the father of Ulysses, we find the pear. Pliny mentions several sorts of pears which were grown in Italy, and particularly mentions that a fermented liquor was formed of their expressed juice. It is probable that the Romans brought the cultivated pear to England, and that the monks paid great attention to its varieties. There is a tradition that King John was poisoned in a dish of pears by the monks of Swinstead; and the tale, whether true or false, would imply that the fruit was such as the churchmen would offer to the monarch as a luxury. In an old book of household accounts of Henry VIII., there is an item of twopence "to a woman who gaff the kyng peres;" and in the time of Gerard, we find that great attention was paid to their growth by the nurserymen in the neighbourhood of London. The old herbalist, after declaring that in his time to write of the sorts of apples and pears, "and those exceeding good," would require "a particular volume," adds, "Master Richard Pointer has them all growing in his ground at Twickenham, near London, who is a most cunning and curious grafter and planter of all manner of rare fruits; and also in the ground of an excellent grafter and painful planter, Master Henry Bunbury, of Touthil street near unto Westminster; and likewise in the ground of a diligent and most affectionate lover of plants, Master Warner, neere Horsly Down, by London; and in divers other grounds about London." The neighbourhood of Worcester was probably then celebrated, as at the present day, for the cultivation of this fruit, for three pears are borne in the arms of the city.

Most of the fine sorts of pears are of continental origin, the horticulturists of France and the Netherlands having paid more attention to that species of fruit than those of England. As these varieties have retained their original names, a good many laughable corruptions have been produced in their popular nomenclature. Thus the *Bon-chrêtien*, is converted into the *Bon-crutching;* the *Beurré* into the *Bury;* the *Chaumontelle* into the *Charmingtel*. Such odd names as the bishop's thumb, and many others which our fruiterers use, may probably be traced to a similar cause. In the names of apples there is the same corruption, as *Runnet* for *Reinette*. The names of fruits in all countries occasionally present some laughable anomalies, such as the "*Bon-Chrêtien Turc*," one of the finest of the French pears.

The Chinese, who are said to carry the cultivation of fruit to much greater perfection than the European gardeners, are stated by Marco Polo to have pears, white in the inside, melting, and with a fragrant smell, of the enormous weight of ten pounds each.

The wood of the pear is much firmer than that of the apple, and it is much less liable to be attacked by insects, or to decay. In some of the old orchards, where the apple trees have wholly disappeared, the pears are in full vigour, and bear abundantly. This is remarkably the case at the old Abbey garden at Lindores, on the south bank of the Tay, in the county of Fife: disease could have nothing to do with the death of the apple trees there, as the soil is one of the very best for apples in the kingdom, being fine strong black loam to a great depth. Yet there are many old apple trees in the kingdom. At Horton, in Buckinghamshire, where Milton spent some of his earlier years, there is an apple tree still growing, of which the oldest people remember to have heard it said that the poet was accustomed to sit under it. And upon the low leads of the church at Rumsey, in Hampshire, there is an apple tree still bearing fruit, which is said to be two hundred years old.

The fruit catalogue of the Horticultural Society contains above six hundred varieties of the pear; and it is there observed, that "the newly introduced Flemish kinds, are of much more importance than the greater part of the sorts which have been hitherto cultivated in Great Britain, and when brought into use will give quite a new feature to the dessert."

Good pears are a luscious fruit. They are characterised by a saccharine aromatic juice, a soft and pearly liquid pulp melting in the mouth, as in the *beurrés* or butter pear; or a firm and crisp consistence, as in the winter bergamots. Kitchen pears should be of a large size, with the flesh firm, neither brittle nor melting, and rather austere than sweet, as the wardens. Pears for the manufacture of *perry*, may be either large or small, but the more austere the taste the better will be the liquor. The wild pear produces an excellent perry.

The best sorts of pear where the space is limited, or for the cottage garden, are: The *jargonelle, Marie Louise, beurrè de capiaumont, beurrè diel, glout morçeau, easter leurrè*, and *beurrè rance*. With the exception of the jargonelle, all these sorts are hardy enough without a wall; but when this can be obtained, the best fruit will be produced.

The propagation of the pear may be accomplished by seeds, by layers, or suckers, but not easily by cuttings: the most approved way is raising seedlings, or grafting and budding. The same principles of selection of seed, and crossing by means of the pollen of different sorts, are applicable to the pear as to the apple. Seedling pears, however, do not so soon bear as apples. At Brussels, according to Neill, seedling pears bear fruit in four or five years; whereas in Britain they seldom bear before the seventh or eighth year. The fruit of the first year of bearing is always inferior to that of the second or third years. If a pear or an apple possesses a white and heavy pulp, with juice of rather pungent acidity, it may be expected in the second, third, and subsequent years, greatly to improve in size and flavour. New varieties of pears, and indeed of all fruits, are more likely to be obtained from the seeds of new than of old sorts.

In grafting the pear, the most common stocks are the common pear and wilding; but as the apple is dwarfed, and brought more early into a bearing state by grafting on the paraden or creeper, so is the pear by grafting on the quince or white-thorn. The pear will also succeed very well on the white beam, medlar, service, or apple; but the wilding and quince are in most general use. On the thorn, pears come very early into bearing, continue prolific, and, in respect of soil, will thrive well on a strong clay. A dry deep loam is reckoned the best soil for the pear tree, when the stock is of its own species; on a quince stock it requires a moist soil. Gravel is a good subsoil where the incumbent soil is suitable.

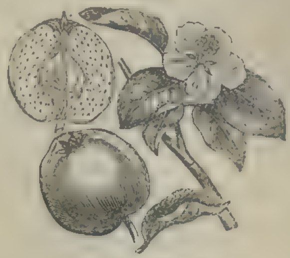
The mode of bearing of the pear differs somewhat from that of the apple. It does not produce blossoms on the former year's wood, but its buds are formed on spurs growing out of wood not younger than one year old, and consequently projecting spurs all over the tree must be left for that purpose.

Pruning is not often wanted in the culture of the pear tree, which is rarely much encumbered with superfluous branches; but in some kinds, whose form of growth resembles the apple tree, it will sometimes be found beneficial. All irregular crowded or decayed branches are of course to be lopped off, and the head is to be kept moderately open in the middle.

Perry is produced from the pear. It is chiefly manufactured in Worcestershire, and from thence is exported to America, and the East and West Indies. It is of a higher and richer flavour than cider, and less acid; and when of genuine quality is highly esteemed, commanding a price equal to that of some of the best continental wines.

THE QUINCE, *(Pyrus cydonia.)* The quince tree is of low growth, much branched, and generally much contorted; the leaves are roundish, or ovate, entire, of a dusky green above, and white underneath, and attached by short petals. The flowers are large, white, or pale red, and appear in May and June. The fruit differs in shape and size in the different varieties. It is large, globular, oblong, or pear-shaped, of a rich yellow or orange colour when ripe, and a strong peculiar odour. Its taste is austere; the pulp is composed of sugar, vegetable jelly, astringent matter, malic acid, &c. The seeds are mucilaginous. The dietetic properties of the fruit are similar to those of the apple and pear. It is mentioned by Tusser as cultivated in England in 1753, but it has now come into general use in this country. Quince pie was once reckoned amongst the delicacies of the table, but it is now rarely produced. To some tastes, quince mixed with other fruit contributes to it an agreeable piquancy.

119



The Quince.

The quince was introduced into Europe, according to Pliny, from the island of Crete. From the largeness of this fruit, and its splendid colour, it is not improbable that it was the same with the apples of the Hesperides; for Galesio, in his treatise on the orange, has shown that the orange tree was unknown to the Greeks, and that it did not naturally grow in those parts where the gardens of the Hesperides were placed by them. The fruit of the quince, however useful and ornamental it may be in some respects, does not warrant such honours, and in truth has not continued to receive them; for the French, who have paid great attention to its cultivation, particularly for grafting pears upon its stocks, call the quince tree "*coignassier*," probably, according to Du Hamel, because the disagreeable odour of the fruit requires that it should be placed in a corner *(coin)* of the orchard or garden. In the south of France, particularly on the borders of the Garonne, the quince is very extensively grown; and the peasants prepare from it a marmalade, which they call *cotig-*

nac. The term marmalade is derived from the Portuguese name for the quince, *marmelo.* Gerard says, that in his time quince trees were planted in the hedges of gardens and vineyards; and marmalade, two centuries ago, seems to have been in general use, principally from a belief that it possessed valuable medicinal properties. The seeds of the quince are still used in medicine, on account of the great quantity of mucilage which they yield to boiling water.

There are eight varieties of the quince noticed in the fruit catalogue of the Horticultural Society. Amongst these the Chinese quince *(cydonia Chinensis)* is inserted on account of the resemblance which its fruit has to that of the common quince; although in France, where only in Europe it has produced fruit, it is not considered eatable. The Chinese quince was introduced into England and Holland nearly forty years ago, and was planted in France about ten years later. The tree has much the appearance of the common quince, as well as the fruit. It is remarkable for the number and brilliancy of its flowers.

The quince is not eaten raw, but is used in pies or tarts, stewed. It also forms an excellent marmalade or syrup. When apples have lost their flavour, the addition of a few quinces adds much to their sharpness and acidity. The expressed juice of the quince was formerly a good deal employed in medicine; as also an infusion of the seeds, which forms a good emollient, similar to that made from the gums.

This tree prefers a soft moist soil, and rather shady situation. It is propagated by layers and cuttings, and approved sorts are perpetuated by grafting.

The Medlar, *(mespilus Germanica.)* This is a middle sized branching tree. The branches are woolly and covered with an ash-coloured bark, and in a wild state armed with stiff spines. The leaves are oval, lanceolate, serrate; towards the point somewhat woolly, and set on very short channeled petioles. The flowers are produced on small natural spurs, at the ends and sides of the branches. The bracteæ are as long as the corolla, the calyxes terminating fleshy, the petals white. The tree flowers in June and July, and the fruit is ripe in November.

The medlar is a fruit resembling the smaller apples, and has a good deal of flavour, but is not fit for use until it is very ripe. This ripeness is seldom or never attained while the fruit remains on the tree. It is generally understood to be a native of the south of Europe; but it has been naturalized, though rarely, in the hedgerows in England.

In Sicily, according to Miller, it rises to be a large tree, with a straight stem, and the fruit shaped like a pear. The Dutch medlar, which is the kind most cultivated in England, does not reach a great height, and is crooked and unsightly in the branches. The leaves are much larger than those of the common medlar, and they are downy on their under sides. The fruit, also, is larger, and so are the flowers; but it is inferior in pungency and flavour to the smaller sort, which is known by the name of the Nottingham medlar.

The timber of the medlar is very hard and durable. The tree is also rather a slow grower, and lasts to a great age.

True Service, *(pyrus domestica.)* This tree is a native of France and Italy. It has also been occasionally found wild in England. At present it is scarcely cultivated in this country, and plants of it are rarely to be met with in our nurseries. It is a middle-sized tree; the leaves are small and pinnated, and villous beneath. It bears a profusion of white flowers. There are two varieties, one bearing an apple-shaped fruit, the other a pear-shaped. These fruits are very small, and, like the medlar, are only eatable when mellowed with age. They have a peculiar acrid flavour. The wood of this tree is very hard and homogeneous; quite free of pores, and is much used in making mathematical rulers.

In France it was also at one time employed in the construction of screws for wine presses. The tree is propagated by seeds, cuttings, and layers; or, in good soils, by grafting on seedlings of the same species. The best soil is a strong clay loam.

Cocoa Plum, *(chrysobalanus,)* literally golden acorn. There are two species of this tropical fruit, the West Indian *c. icaco,* and the American *c. oblongifolius.* The icaco bears flowers and fruit similar to those of the plum. This fruit is common in the West Indies, and is eaten both raw and preserved; both species grow well in a sandy loam. They are propagated by large cuttings, taken off at a joint.

The Loquat, *(criobotrya japonica.)* This is also a tropical plant, belonging to the pomaceæ. The leaves are lanceolate and serrated, the fruit about the size of a gooseberry, of a fine yellow colour, and, according to Sir Joseph Banks, as good as the mango. To bring it to maturity in this country, it requires the heat of a stove, and it comes into use in March. It may be grafted on any species of the genus, or on the hawthorn.

Amygdalus. This, the Greek name of the almond, forms a genus of fruit trees and shrubs, comprehending the peach, nectarine, sweet and bitter almond, dwarf almond, and a few others. The leaves are lanceolate or obovate, with serrated edges; the flowers make their appearance early, and are of a delicate gray colour. The peach and nectarine are the most delicious of European fruits: the sweet almond is esteemed for its kernel, which contains a quantity of bland fixed

oil. The dwarf and double dwarf almonds, are pretty ornamental shrubs.

THE PEACH AND NECTARINE, (*amygdalus Persica.*) The peach, when growing naturally, is

120.

The Peach.

rather under the middle size of trees, with spreading branches, of quick growth, and not long lived. The blossoms come out before the leaves are fully expanded; they are of a gay delicate colour, but with little odour. The fruit is round, with a furrow on one side, and with a delicate downy skin. Sickler considers Persia as the original country of the peach, which in Media is esteemed unwholesome; but when planted in the alluvial soils of Egypt, becomes pulpy, delicious, and salubrious. The peach also, according to Columella, when first brought from Persia into the Roman empire, possessed deleterious qualities, which Knight concludes to have been from those peaches being only swollen almonds, or imperfect peaches, and which are known to contain the prussic acid, a poisonous substance. The flesh of the almond is at this day considered as poisonous on some parts of the continent. The tree has been cultivated from time immemorial, in most parts of Asia. At what period it was introduced into Greece is uncertain. The Romans seem to have brought it direct from Persia, during the reign of the Emperor Claudius. It is first mentioned by Columella, and afterwards described by Pliny. The peach was introduced into England about the middle of the sixteenth century, where it is always cultivated against walls or under glass. The peach is more grateful to the palate than perhaps any other fruit raised in England, either naturally or by art, with the exception of the luscious, mellow-flavoured pine apple. It surpasses the grape in richness, and is more delicate than the melon.

Linnæus divides the peach into two varieties, that with downy fruit, or the peach, commonly so called, and that with smooth fruit, as the nectarine. There are various instances of both fruits growing on the same tree. Thus, trees raised from the stone or seed, have not only borne fruit having on one part of the tree the downy coat of the peach, and on another the smooth coat of the nectarine, but they have exhibited varieties even closer than that, for single fruits have been produced with the coat of the peach on the one side, and that of the nectarine on the other.*

The French consider them as identical, and arrange the peach into four divisions. 1. The free stone peaches, the flesh of whose fruit separates readily from the skin and the stone; 2. The free stone nectarines, or smooth peaches; 3. The cling-stone peaches, whose flesh is firm, and adheres both to the skin and the stone; 4. The cling stone smooth peaches. The double blossomed peach is one of the most ornamental of spring flowering trees. It is about three weeks later of blossoming than the common peach.

In the warmer parts of Asia the peach is very generally cultivated, and in many it grows abundantly without culture.

On some parts of the American continent also, the peach grows readily, and in great plenty. Captain Head, in his Rough Notes, mentions the beauty and productiveness of the peach trees which are scattered over the corn fields in the neighbourhood of Mendoza, on the east side of the Andes; and the same traveller notices dried peaches as an article of food in the mountainous parts, to which they must of course be carried from the plains.

In many parts of the United States, peach trees grow in extensive plantations. They continue without culture; and the fruit is of little value, except in the distillation of peach brandy, and the fattening of hogs. The following account of the peach orchards in the United States, and of a variety of peach which the describer obtained from that country, was communicated to the Horticultural Society in 1815, by Mr John Braddick, of Thames Ditton:—

"Some years ago, when travelling through Maryland, Virginia, and the neighbouring provinces of the United States of America, I had an opportunity of observing the mode in which the peach trees of those provinces were cultivated, which was invariably from the stone of the peach, the plant being never budded, but always remaining in a state of nature. In the middle and southern provinces of the United States, it is no uncommon circumstance for a planter to possess a sufficient number of peach trees to produce him, after fermenting and distilling the pulp, from fifty to one hundred gallons of peach brandy; the manufacturing of this liquor, and the feeding of hogs, being the principal uses to which the peach is applied in those countries. A peach orchard usually contains a thousand or more standard trees. The tree being raised in the manner I have detailed, it is easy to conceive that the fruit growing on them must be an endless variety, scarcely two trees

* Horticult. Transact. Vol. I.

producing exactly alike; and although by far the greater number of trees, in any of these orchards, will always be found to produce fruit below mediocrity in point of flavour, yet a judicious observer will never fail, among so great a number, to pick out a few trees, the race of which may be considered worthy of preserving."

The peach is said to have been first cultivated in England about the middle of the sixteenth century. Gerard describes several varieties of peach as growing in his garden. Tusser mentions it among his list of fruits in 1557.

In the neighbourhood of Paris much attention is paid to the culture of peach trees; and the peaches there are of excellent quality. The principal gardens for the supply of the French capital are at Montreuil, a village near Paris; and one tree there sometimes covers sixty feet of wall, from the one extremity to the other. The Montreuil peaches are of the finest flavour; and their excellence is properly attributed to the exclusive attention of the people to their culture. The sub-division of labour and skill produces the same results in every art.

The espalier peaches of the Duc de Praslin, near Melun, are stated to be the finest in Europe.

All the peaches have in the kernel a flavour resembling that of noyau, which depends on the presence of prussic or hydrocyanic acid. The leaves have the same flavour, which they impart by infusion either in water or in spirits.

The facility of raising the peach from the stone has probably tended to its general diffusion throughout the world. This fruit has steadily followed the progress of civilization; and man, "from China to Peru," has surrounded himself with the luxury of this, and of the other stone fruits, very soon after he has begun to taste the blessings of a settled life. There are still spots where ignorance prevents portions of the human race from enjoying the blessings which Providence has everywhere ordained for industry; and there are others where tyranny forbids the earth to be cultivated and produce its fruits. The inhabitants of the Hauran, who are constantly wandering, to escape the dreadful exactions of some petty tyrant, have neither orchards nor fruit trees, nor gardens for the growth of vegetables. "Shall we sow for strangers?" was the affecting answer of one of them to Burckhardt.

The peach is raised from the stone, and this mode is pursued in America, even for procuring trees for common purposes. Knight produced varieties in the following manner. He planted dwarfs in large pots; these being brought into a state of vigorous health, the pistils of the blossom of one sort were impregnated with the pollen of another, only three peaches were suffered to remain on each tree; and from sowing the stones of these, the Acton Scot, the spring grove, and other varieties were produced. Knight also maintained "that the peach tree might, in successive generations, be so far hardened and naturalised to the climate of England and Ireland, as to succeed well as a standard in favourable situations. The peach does not, like many other species of fruit trees, exercise the patience of the gardener who raises it from the seed; for it may always be made to bear when three years old." Mr Knight even succeeded in producing blossom buds the first year.

The peach is generally budded on damson, plum stocks, and some of the more delicate sorts; on apricot stocks, or old apricot trees cut down, or on seedling peaches, almonds, or nectarines. The soil best suited for the peach is "three parts mellow, unexhausted loam; and one part drift sand, mixed with vegetable mould or manure." Peaches require a lighter soil than pears or plums.

All the varieties bear the fruit upon young wood of a year old, the blossom buds rising immediately from the eyes of the shoots. The same shoot seldom bears after the first year, except on some casual small spurs on the two year's wood. Hence the trees are to be pruned, as bearing entirely on the shoots of the preceding year, and a full supply of every year's shoots must be trained in for successorial bearers the following season. The following are short and useful hints: "Use a strong loam for the border, never crop it, add no manure, keep the trees thin of wood by disbudding, and the early removal of useless wood; shorten each shoot according to its strength at the spring pruning, elevate the ends of the leading branches, so that they may all form the same curvilinear direction upwards, and keep the trees in a clean and healthy state."* Various species of *aphis*, and the *acarus*, or red spider, infest the leaves of the peach.

One of the greatest blessings, says a recent writer,† that can be conferred upon any rude people, (and it is a blessing which will bring knowledge, and virtue, and peace, in its train) is to teach them how to cultivate those vegetable productions which constitute the best riches of mankind. The traveller Burchel rendered such a service to the Bachapins, a tribe of the interior of southern Africa. He gave to their chief a bag of fresh peach stones, in quantity about a quart; "nor did I fail," says the benevolent visitor of these poor people, "to impress on his mind a just idea of their value and nature, by telling him that they would produce trees which would continue every year to yield, without further trouble, abundance of large fruit of a more agreeable flavour than any which grew in the country of the Bachapins." This is an interest-

* Callow.

† Library of Entertaining Knowledge.

ing example of how much good a right minded and active individual may do to his humbler brethren of the human family. "Why have not every where the names been preserved," says Humboldt, "of those who, in place of ravaging the earth, have enriched it with plants useful to the human race?" It is satisfactory to observe, however, that when men are highly civilized, there is an elasticity in their mental energies, which makes the destruction of tyranny and war of less permanent injury than when their inflictions fall upon a rude people. Sickler, a distinguished naturalist of Germany, who has paid particular attention to the cultivation of fruit trees, had, in the Duchy of Saxe Gotha, formed three nurseries for fruit trees, one of which contained eight thousand grafted plants. In 1806, this nursery was entirely destroyed by the French, after the battle of Jena: Ney's corps bivouacked in it. After the battle of Leipsic, in 1814, another nursery, planted by the same eminent man, was destroyed by the Cossacks. Yet in 1817 he had planted and reared a third nursery with his own hand,—persevering, in spite of the injuries which he had received in these dreadful contests to distribute his fine plants, and the knowledge of their cultivation, over his native country. The labours of such a man will endure when the fame of conquerors is forgotten, or thought worthless, or only remembered to be hated as it deserves.

It has been already stated that some doubts exist as to the difference between the peach and the almond being more than apparent. With reference to this subject, there is a curious fact recorded by the president of the Horticultural Society. The fruit of a sweet almond tree, which had been obtained from an almond kernel, that had, when in flower, been impregnated with peach pollen, was sown, and produced a tree: this tree bore eight peaches, some of which were perfect, and the others burst at the centre when ripe, as is the case with almonds. The peaches were finely formed and coloured; the flesh white, soft, melting, and of good flavour. This experiment is curious; for though it does not completely establish the fact of the convertibility of an almond into a peach, it does so in great part, by showing that only the pollen is necessary to effect such a change.

The *Flat Peach of China* is perhaps the most singular of the peach tribe. The size of it resembles that of the apple; and the stalk and eye approach so near as to give it the appearance of a ring of flesh, with a stone in the middle. The following description accompanied specimens presented to the Horticultural Society by Mr Braddick:—

"This fruit is of truly singular form, and perhaps will be best described as having the appearance of a peach flattened by pressure at the head and stalk; its upright diameter, taken through the centre, from eye to stalk, being eleven sixteenths of an inch, consisting wholly of the stone, except the skin; that of its sides is one inch and one-eighth, its transverse diameter being two inches and a half. The head of the fruit is crooked in such a manner, as to look like a broad and rather hollow eye of an irregular and five-angled, (or lobed) shape, surrounded by the appearance of the remains of the leaves of a calyx: the whole surface of this eye is roughly marked with small irregular warted lines, like the crown of a medlar. The colour of the skin of the fruit is pale yellow, mottled, or rather speckled with red on the part exposed to the sun, and covered with a fine down. The flesh is pale yellow, having a beautiful radiated circle of fine red surrounding the stone, and extending far into the fruit. The stone is flatly compressed, small, rough, and irregular. The consistence and flavour of the flesh is that of a good melting peach, being sweet and juicy, with a little noyau flavour, or bitter aroma. This peach is cultivated in China, representations of it being continually seen on the papers and drawings received from that country; and it is well known at Canton, where it is esteemed as a good fruit."

THE ALMOND, *(amygdalus communis,* and *a. amarus.)* The sweet and bitter almond trees

121.

The Almond.

are similar in appearance to the peach, and grow to the height of about twenty feet, with spreading branches, and blossoms of a more varied colour than the peach.

It is probable that the almond is a native of the western parts of Asia. The almond is mentioned in the Scriptures as amongst the best fruits of the land of Canaan. It is very plentiful in China, in most of the eastern countries, and also in Barbary. In that country it is the most early bearer of all the fruit trees. It flowers

in January, and gives its fruit in April. It does not appear that the almond tree, (which is now abundantly cultivated for its fruit in Italy, Spain, and the south of France) was so early introduced into the first of these countries as the peach, or that its native region was so well known, "Greek nuts" being the name given to almonds at Rome in the time of Cato.

The fruit of the almond is not so attractive as that of the peach; because, instead of presenting the same delicious pulp as that, the pericarp of the almond shrivels as the fruit ripens; and when the ripening is completed, has become a horny kind of husk, which opens of its own accord. The kernel of some varieties of the almond, is not defended by so tough a shell as that of the peach and nectarine; for it is often so tender that the nuts break when shaken together.

In the south of Europe, where the almond is cultivated with as much care as the peach is in this country, its varieties are carefully distinguished. The bitter and the sweet are permanently distinct varieties; and after this leading character is observed, the variety is further distinguished by the form and degree of hardness of the shell. For instance, the French have, "amandier à coque dure"—"amandier à coque demi-dure"—"amandier à coque tendre."

In England, almond trees are chiefly cultivated for the beauty of their early flowers; and for this reason, the common kind, and the double-flowering dwarfs, are preferred. There is something very charming in the peculiarity which belongs to this tree, of blossoming on the bare branches:

> "The hope, in dreams, of a happier hour,
> That alights on misery's brow,
> Springs out of the silvery almond-flower,
> That blooms on a leafless bough."

One of the most beautiful tales of the Greek mythology (that of the Loves of Phylis and Demophoon) is founded on this property of the almond tree.

The almond is raised from seed like the peach, for varieties or for stocks; and by budding on its own or on plum stocks, for continuing varieties. The fruit is produced chiefly on the young wood of the previous year, and in part on small spurs of two or three years' growth.

Almond trees ripen their fruit in England, though the produce is very inferior to that which is imported. The flowers of the productive almond, both the sweet and the bitter, are much less showy than those of the unproductive. Like most of the other nut-bearing trees, the almond yields an oil. Between the expressed oil of bitter, and that of sweet almonds, there is little difference; but the bitter almond contains an essential oil, while the sweet almond has none. Owing to the prussic acid which it contains, this essential oil is found, by experiment, to be exceedingly poisonous; and therefore the use of bitter almonds should be carefully avoided in every instance where there is a chance that the essential oil may be separated in the stomach. So very violent is the poison of this oil, that instances are recorded of persons dying in consequence of drinking even a very small portion of spirits flavoured by it; and, in its concentrated state, it is probably not exceeded, in its hurtful effects, even by the essential oil of tobacco itself, or by any of the narcotic vegetable poisons.

According to Haller, bitter almonds are a poison to birds and quadrupeds.

Almond oil (the expressed oil) is principally obtained from the almonds of Valentia and Barbary; the Syrian almonds, usually called Jordan almonds, being preferred for the table.

The *Large Fruited Almond (var. macrocarpa)* is one of the most beautiful varieties of the almond. The flowers are twice as large as those of the common sort, and remain longer in perfection: the fruit also is larger. There is a specimen in the garden of the Horticultural Society, which has been figured and described by Mr Lindley in the Botanical Register; who remarks, that this almond is "increased by budding upon plums and other drupaceous plants."

About four hundred and fifty tons of almonds are annually imported into Great Britain, paying a duty of £18,000.

Prunus. This genus comprehends the apricot, the plum, the cherry, the sloe, the laurel, and several other ornamental shrubs. The designation *prunus*, is of Greek origin, but its derivation or particular meaning is unknown. This family are characterised by all the species possessing, in greater or less degree, a portion of prussic acid. In fact, many of the species are decidedly poisonous; and though the fruit of some of them is agreeable to the taste, and safe enough when taken in limited quantities, there is none of the family that can be indulged in to excess with impunity. Columella says that the Persians sent the peach to Egypt to poison the inhabitants; and a species of apricot is called by the people of Barbary, "matza Franca," or the killer of Christians. All these evil qualities are, however, destroyed by cultivation; for it is the privilege of man not only to distinguish between the good and evil properties of vegetables, but to eradicate the evil, in many cases, by his skill and industry.

The Apricot, *(prunus Armeniaca.)* The apricot is a low tree of rather crooked growth, with subcordate leaves and sessile flowers. The fruit is round, about the size of the peach, and resembling it in delicacy of flavour.

The apricot is very widely diffused in Asia, and grows upon the slopes of the barren mountains westward of China. Many species of it

are cultivated; and, as they ripen earlier than the peach and nectarine, they are in considerable estimation. Some varieties are exceedingly delicious; and the Persians, in their figurative language, call the apricot of Iran "the seed of the sun."

It should seem that the apricot was known in Italy in the time of Dioscorides; and that it got its name *precocia* from ripening earlier than some other fruits. The modern Greek name περικυκκα is very like the Arabic name berikach. The Romans set little value upon the apricot, as appears by an epigram of Martial. If the ancient name is to be retained, a-precoke, as it used to be styled by our most early writers on horticulture, is the classical appellation, and the modern apricot the vulgarism or corruption.

The apricot is said to derive its scientific name from its almost covering the slopes of the Caucasus, the Ararat, and the other mountains in and about Armenia, up almost to the margin of the snow. The general opinion that it is a native of Armenia has, however, been controverted by M. Regnier, a French naturalist, who contends, that as Armenia is a high mountainous country, the climate of which resembles that of middle Europe, it cannot possibly be the country of a tree which begins to flower so early, that its blossoms are often destroyed by the frost, notwithstanding every care of the cultivator. The apricot, too, although it has been cultivated in Europe for many ages, never sprang up from seeds in any of our forests; neither has it been found wild either in Armenia or any of the neighbouring provinces. M. Regnier is of opinion that it is a native of Africa, and that its limits appear to be a parallel between the Niger and the range of the Atlas mountains, from whence it has, by cultivation, been carried towards the north.

Apricots are very plentiful, and in great variety, in China; and the natives employ them variously in the arts. From the wild tree, the pulp of whose fruit is of little value, but which has a large kernel, they extract an oil; they preserve the fruit wet in all its flavour; and they make lozenges of the clarified juice, which afford a very agreeable beverage when dissolved in water. The apricot attains the size of a large tree in Japan. It also flourishes in such abundance upon the Oases, as to be dried and carried to Egypt as an article of commerce. In those sultry climates, the flavour is exquisite, though the fruit is small.

Gough, in his British Topography, states that the apricot tree was first brought to England, in 1524, by Woolf, the gardener to Henry VIII. Gerard had two varieties in his garden.

There are fifteen or twenty excellent varieties of apricot, besides the peach apricot, a large fruit supposed to be a hybrid, between a peach and an apricot.

New varieties are procured by planting the seed; and approved sorts are propagated by budding on plum stocks. The trees are trained against the wall, and bear in the open air, in all the sheltered parts of Britain. The fruit is produced on the young shoots of last year, or sometimes on two or three year old spurs. The bearing shoots throw out the blossoms immediately from the eyes along the sides, and the buds have a round and swelling appearance. The apricot does not force well.

The Plum, *(prunus domestica.)* The plum appears to be still more widely diffused in its original locality than the apricot; and it is much more prone to run into varieties. It is a tree of fifteen to twenty feet in height, and branches out into a moderately spreading head. It is a native of Asia, and of many parts of Europe; and even grows wild in the hedges in some parts of Britain, though possibly it may have found its way there from some of the cultivated sorts, and have degenerated. The plum, and almost all its species, is very apt to run under ground, and produce suckers from the roots. Du Hamel says that if plums are grafted low, and covered with earth, they push out shoots which may be transplanted.

122.

The Plum.

Plums of various sorts appear to have been introduced into England as early as the fifteenth century. These varieties came to us from France and Italy. The "Green-gage" is the *Reine Claude* of France, so called from having been introduced into that country by the wife of Francis I. It is called gage in England, after the name of the family who first cultivated it here. The "Orleans" probably came to us when we held possession of that part of France from which it takes its name. Lord Cromwell introduced several plums from Italy, in the time of Henry VII. The damson, or damascene, as its name imports, is from Damascus.

In some countries, particularly in Alsatia, a considerable quantity of alcohol is produced from plums and cherries by fermentation. Dried plums form a large article of commerce, under the name of prunes and French plums.

There are nearly three hundred varieties of plums, many of which are, perhaps, only dissimilar in name. The Washington, a modern variety, which is stated in the Pomological Magazine not to be surpassed in richness of flavour, beauty, and other good qualities, by any, is curious in its origin. The parent tree was purchased in the market of New York, some time in the end of last century. It remained barren several years, till, during a violent thunder-

storm, the whole trunk was struck to the earth and destroyed. The root afterwards threw out a number of vigorous shoots, all of which were allowed to remain, and finally produced fruit. It is, therefore, to be presumed that the stock of the barren kind was the parent of this. Trees were sent to Mr Robert Barclay, of Bury Hill, in 1819; and in 1821 several others were sent to the Horticultural Society by Dr Hosack.

Most of the varieties of the plum are propagated by grafting or budding on the muscle, St Julian magnum bonum, or any free growing plums raised from seed or from suckers; but for a permanent plantation seedlings are to be preferred. The common baking plums, as the damson, bullace, Wentworth, are generally propagated by suckers, without being either budded or grafted. Plumb-grafting is performed in July or March; budding in July or August. A middling light soil, neither too wet or too dry, is best suited for this tree.

All the sorts produce their fruit on small natural spurs, rising at the ends and along the sides of the bearing shoots, of one, two, or three years' growth. In pruning, the fruitful branches should not be shortened, but thinnings made of cross placed or irregular branches.

THE CHERRY *(prunus cerasus)*. The cultivated cherry is by some considered a distinct species, while others suppose it a domesticated variety of the wild cherry or gean. Besides being prized for its fruit, the cherry is also a very ornamental tree, and cultivated for this object in shrubberies. The tree is a native of most temperate countries of the northern hemisphere. The small black is found not only in some parts of England, but even in places among the Scottish mountains, where it would be difficult to imagine it to have been carried. It is generally said that the first of the present cultivated sorts was introduced about the time of Henry VIII., and were originally planted at Sittingbourn, in Kent. The cherry orchards of Kent are still celebrated. It seems, however, that they were known much earlier, or, at any rate, that cherries were hawked about London before the middle of the sixteenth century, in the very same manner as at present. The commencement of the season was announced by one carrying a bough or twig loaded with the fruit. Our present popular song of "Cherry ripe, ripe I cry," is very slightly altered from Herrick, a poet of the time of Charles I. One of our old English games, *cherry-pit*, consisted of pitching cherry-stones into a little hole:—"I have loved a witch ever since I played at cherry-pit."* Shakspeare also alludes to the same custom.

The wild cherry, of which there are a good many varieties, is a much more hardy tree than any of those that produce the finer sorts of fruit; and it is therefore much cultivated for stocks upon which to graft the others, as trees so grafted attain a larger size, are more durable, and less subject to disease. At some of the ruined abbeys and baronial castles there are found cherry trees, chiefly black ones, which have attained the height of sixty or eighty feet, and continue to produce great quantities of fruit. These ancient sorts are not confined to the warmer parts of the country, but are met with in some of the northern counties of Scotland. Evelyn ranks the black cherry amongst "the forest berry-bearing trees, frequent in the hedges, and growing wild in Herefordshire and many places."

The cherry is generally understood to have been brought to Rome, from Armenia, by Lucullus, the conqueror of Mithridates. This was about sixty-eight years before the Christian era; and such was the fondness for the fruit, that Pliny says, "in less than one hundred and twenty years after, other lands had cherries, even as far as Britain beyond the ocean." The cherry is spread over Africa. In Barbary it is called "The Berry of the King." Desfontaines *(Histoire des Arbres)* contends, in opposition to the received opinion, that the wild cherry is indigenous to France, and of equal antiquity with the oak; nor can we help thinking, from the situation in which we have seen wild cherries, that the same may be the case with parts of the United Kingdom.

The transplantation of fruit trees from one distant locality to another has been employed by Hume as an argument to prove "the youth, or rather infancy of the world," in opposition to the opinions of those who maintain that this earth has existed, in its present condition, from countless ages:—

"Lucullus was the first that brought cherry trees from Asia to Europe; though that tree thrives so well in many European climates, that it grows in the woods without any culture. Is it possible that, throughout a whole eternity, no European had ever passed into Asia, and thought of transplanting so delicious a fruit into his own country? Or if the tree was once transplanted and propagated, how could it ever afterwards perish? Empires may rise and fall; liberty and slavery succeed alternately; ignorance and knowledge give place to each other; but the cherry tree will still remain in the woods of Greece, Spain, and Italy, and will never be affected by the revolutions of human society.

"It is not two thousand years since vines were transplanted into France, though there is no climate in the world more favourable to them. It is not three centuries since horses, cows, sheep, swine, dogs, corn, were known in America. Is it possible that, during the revolutions of a whole eternity, there never arose a Columbus who

* Witch of Edmonton.

might open the communication between Europe and that continent? We may as well imagine that all men would wear stockings for ten thousand years, and never have the sense to think of garters to tie them. All these seem convincing proofs of the youth, or rather infancy, of the world, as being founded on the operation of principles more constant and steady than those by which human society is governed and directed. Nothing less than a total convulsion of the elements will ever destroy all the European animals and vegetables which are now to be found in the western world."

Several liqueurs are manufactured from cherries. A large black cherry *(Merise noire)* is used in the composition of the *ratafia* of Grenoble; and the *maraschino* of Zara is prepared from a particular species of cherry cultivated in Dalmatia. *Kirschwasser*, which is a cheap spirit, forming a considerable article of commerce, is the fermented liquor of a small black cherry.

The whole of the genus *prunus* yield what is commonly called gum, that of the cherry tree being the best. But this substance, which is called *cerassin*, resembles *tragacanth* (the gum of the *astragalus*), and is therefore improperly called gum, as the term is usually understood, and applied to gum Arabic.

The Romans had eight varieties of cherry. In the British gardens are upwards of forty sorts. The French divide the cherries into *griottes*, or tender-fleshed; *bigarreaux*, or hard-fleshed; and *guignes*, or small fruits. The fruit of many varieties is somewhat heart-shaped; hence the very general name of *heart-cherry*. Why some are called *dukes* is not so well ascertained. The Morello cherry is very distinct from the other varieties, bearing almost exclusively, in the preceding years, stock wood, and the pulp of the fruit has somewhat of the consistence and flavour of the morel; whence the name.

Varieties of the cherry are continued by grafting, or budding on stocks of the black or wild red cherries, which are strong shooters, and of a longer duration than any of the garden kinds. Some graft on the Morello, for the purpose of dwarfing the tree, and rendering it more prolific; but the most effectual dwarfing stock is the *mahaleb*, which, however, will not succeed in the generality of soils in Britain. For procuring new varieties, however, recourse must be had to raising from the seed. From these a good many new sorts may be expected. The stones are planted in light sandy soil, in autumn or spring. They will germinate the same year, but should not be planted out till the second autumn after sowing. The cherry thrives best in a dry, light, sandy soil, and an elevated situation. Some sorts, as the May-duke, will thrive in all soils and aspects. Early fruit is obtained from wall trees; but the cherry does equally with espaliers or standards. Insects, as the red spider, attack the wall-cherry; but the other sorts are not very liable to be preyed on by such vermin.

The Chinese Cherry (prunus pseudo-cerasus) is a valuable new species of that fruit, introduced into this country so recently as 1819. The following is an extract from the account of this variety, presented to the Horticultural Society by Mr Knight, their president:—

"I received a plant of the Chinese cherry from the garden of the Horticultural Society in the summer of 1824, after it had produced its crop of fruit; and it was preserved under glass, and subjected to a slight degree of artificial heat till the autumn of that year. It appeared very little disposed to grow; but produced one young shoot, which afforded me a couple of buds for insertion in stocks of the common cherry. Soon after Christmas the tree was placed in a pine-stove, where it presently blossomed abundantly, and its fruit set perfectly well, as it had previously done in the gardens of the Society, and it ripened in March. The cherries were middle-sized, or rather small, compared with the larger varieties of the common cherry, were of a reddish amber colour, very sweet and juicy, and excellent for the season in which they ripened. The roots of the tree were confined to rather a small spot, and the plant was not even in a moderately vigorous state of growth. I therefore infer that the fruit did not acquire either the size or state of perfection which it would have attained if the tree had been larger and in a vigorous state of growth, and the season of the year favourable."

The Gean (prunus avium), the French *guigne*, is a tall tree common in woods in some parts of England, and frequently growing wild in Scotland. The fruit is smaller than that of the common cherry, of a red colour when unripe, and a deep purple or black when it arrives at maturity. The flavour is superior to that of most cherries. Indeed, the *cerone*, or black cherry, is supposed to be an improved variety of the wild gean. The wood of this tree is used for many kinds of domestic furniture, and other purposes.

The Bird Cherry (prunus padus). This is a Greek name given to this tree by Theophrastus. It is in shrubberies very ornamental, from its purple bark, bunches of white flowers and berries, which are successively green, red, and black. It is common in the native woods of Sweden and Scotland, and in both countries the berries are infused in spirits in order to give them an agreeable flavour. The fruit is nauseous to the taste, though greedily eaten by birds. The bark has been employed by the Swedes and Finlanders in medicine. The tree is very leafy, and dislikes a wet soil. The wood is beautifully veined, and is used for cabinet work in France, as is that of the *prunus Virginiana* in America.

The Cornish Bird-Cherry (p. rubra) very much resembles the *padus*.

The Sloe *(prunus spinosa)*, is also indigenous in Britain, and is frequently met with in a wild

123.

The Sloe.

state in Scotland. It is a low shrubby tree, with elliptical lanceolate leaves, pubescent beneath; the branches armed with hard strong spines; the blossom resembling the prune, and the fruit round, of a deep black colour, and extremely austere astringent taste. Some have supposed the sloe the original of the cultivated plum. It is used as stocks on which to engraft the plum and some other species.

The Laurel *(prunus lauro-cerasus)*. This is one of the most generally prized evergreens. It was brought from Constantinople to Holland in 1576. The first we read of in England was one at Highgate, in the garden of Mr James Cole, a London merchant, who, as Parkinson informs us, was in the practice of covering the plant in winter with a blanket. In less than half a century after this, we are told by Ray, that the laurel became a common shrub in English gardens. It is now universally a conspicuous object in almost every shrubbery. The leaves contain a considerable quantity of prussic acid, and from this circumstance have been used to give an agreeable flavour to various articles of food. Much caution, however, ought to be employed not to use the juice of these leaves in excess, otherwise they will prove a virulent poison. The laurel water, distilled from the recent leaves, contains all the active principle of the prussic acid. This has been used criminally for producing death; and several cases of accidental poisoning have arisen from cordials flavoured with the infused leaves of the laurel. The laurel bears a small red berry, which is also poisonous.

The Portuguese Laurel (p. Lusitania) is also a highly admired evergreen shrub. It was brought to England from Portugal, though it does not appear to be a native of that country. It probably is indigenous to Madeira, or some more southern islands.

Rubus, a family of the *rosaceæ*, includes the raspberry, bramble, cloud berry, and several other species. Many of them are only biennial woody plants, producing suckers or stolones from the roots, which ripen and drop their leaves one year, and resume their foliage, produce blossoms, shoots, flower, and fruit, and die the next. Of this kind are the raspberry and bramble.

Raspberry *(rubus idæus)*. This well known plant is indigenous to Britain; but has been greatly improved, both in size and flavour, by cultivation. There are several varieties, as the common, red, and yellow, the double-flowered, and a variety that bears twice a year, in July and September.

This plant obtains its common name from the rough and bristly appearance of the fruit. The French call the raspberry *Ronce du Mont Ida*, (in common parlance, *Framboise*), considering it a native of that classic ground, for which they have the authority of Pliny. The root is perennial and spreading, but the stems last only two years. Both the red and the yellow varieties prefer situations that are shaded and rather moist. The uses of the raspberry, both for the table and for sweetmeats, are well known. Though the flavour of raspberries is peculiar, it is one which is very generally liked; but it is the most fleeting with which we are acquainted. Even a few hours will diminish it; and if the berries be kept for two or three days, the flavour is almost entirely gone. Even on the bush, the flavour does not continue above two or three days after the fruit is ripe. Raspberries, indeed, to be enjoyed in perfection, should be eaten from the bush. They require less attendance than almost any other fruit; and if the twice-bearing kind be mixed with the others, they may be continued till November. The shrubs come into full bearing about three years after the planting of the stools or roots, and they last good for about three years more, at the end of which they begin to degenerate. The common mode of propagation is by cuttings, which should always be taken from plants that are in their prime bearing condition, on or about the fourth year after they are planted. A quantity of peat or bog-earth greatly improves both the size and the flavour of raspberries. New varieties may easily be obtained from the seed, the plants raised from which begin to bear the second year. There are thirty-five varieties of raspberry mentioned in the Fruit Catalogue of the Horticultural Society, of which the differences in quality are very considerable.

When a plantation is made of several rows together, it may be placed in the open garden, as the plants will shade one another to a sufficient degree. Frequent renewal is necessary, to prevent the stools getting large and matted, when they send up only weak suckers. No more suckers should be left at the stools than are in-

tended to bear the following year, unless young plants are wanted; and if very large fruit is the object, no suckers should be left at all; on the contrary, when the strongest suckers are wanted, the fruit-bearing shoots should be cut down.

The raspberry requires a rich moist soil and a shaded situation, where plants grow singly. The best varieties are the early prolific, Barnet, and Cornwallis, seedling and large red, red Antwerp, yellow Antwerp, Bromley hill, Cornish, double-bearing.

The American Raspberry (R. occidentalis), is a showy plant for large shrubberies. The fruit of the *dew berry, r. cæsius*, is blue, and it continues till frost comes on. It is an edible berry, but possesses no very high flavour.

THE BRAMBLE *(rubus fruticosus)* Though the bramble is rather annoying with its long trailing stems and its sharp thorns, the fruit, commonly called *blackberry*, is perhaps in its wild state (and it does not need to be cultivated), among the best, and certainly it is the most abundant, of our native berries. The bramble prefers a soil that is moderately good; but it is found in every situation, except marshes, to the borders of which it creeps very close. On the slopes of the Welsh mountains, more especially in Denbighshire, the bramble berry grows to the size of a middling gooseberry; and in a dry and sunny autumn is really an excellent fruit. Pliny mentions the mulberry growing on a brier, which probably was a fine blackberry. In England there are a number of species confounded under the names of *rubus fruticosus*, and *rubus corylifolius*, that vary very much in the quality of their fruit, some of them really deserving cultivation. The family of brambles is divided into those with upright stems, those with prostrate stems, and those with herbaceous stems.

The Corylifolius and *Fruticosus* are both common in our hedges. The shoots of the latter are much tougher than those of the former, and are preferred by thatchers for binding their roofs, and by straw-hive and mat makers. The berries, eaten at the moment they are ripe, are cooling and grateful; a little before, they are acid and astringent, and a little after, disagreeably flavoured and astringent.

The Arctic or Dwarf Crimson (rubus arcticus) is a small species, and a native of the coldest regions of the world. Its fruit, however, is exceedingly delicious; and were it possible to cultivate it in any habitable situation, it would be a most important addition to garden berries. We have not heard of its ever having been found either in England or in the Welsh mountains; and in Scotland it grows only in the most wild and elevated situations. Some of the Scottish horticulturists have tried to raise it from the seed, and have, we believe, obtained plants; though the fruit, when they bore any, has been tasteless, and the plants themselves are preserved alive with difficulty. The Arctic berry, which grows in the wildest and most exposed districts of Lapland, sometimes offered to Linnæus the only food which he found in his perilous journey in those dreary regions; and he thus speaks of it with much feeling:—"I should be ungrateful towards this beneficent plant, which often, when I was almost prostrate with hunger and fatigue, restored me with the vinous nectar of its berries, did I not bestow on it a full description."

THE CLOUD-BERRY *(rubus chamæmorus)*, called also, in some parts of Scotland, the roe-

124.

The Cloud-berry.

buck berry and knot berry. They grow on the sides about the base of Alpine mountains; but are only found in particular localities. The plant is small, with a rather large handsome leaf, indented and serrated at the edges. A single berry grows on the top of the stem. They are about the size of small strawberries, and the flavour is exceedingly fine, superior to that of any of the strawberries as found wild in this country, and having a sharpness which does not belong even to the best of those which are cultivated. They remain in season for about a month; and during that time, the Highlanders, in the districts where they are found (for they are by no means generally diffused over the Highlands), collect them in considerable quantities, and make them into excellent preserves. In the east, as well as the north, the wild berries of the mountains and valleys, which nature offers in such abundance for a short season, are thus used by man.

This berry has not hitherto been raised in gardens, as it seems difficult of naturalization to any but its native soil and climate. Loudon thinks, by raising it from seeds, and again from the seeds of plants so raised, and so on for six or eight generations, perhaps at the same time crossing the flowers with those of the bramble or raspberry, this plant might possibly become a valuable accession to our native fruits.

In more northern countries the cloud-berry is still more abundant, so much so as to justify the encomium passed on it by the poet, while speaking of those dreary lands:—

> "Ever enduring snows, perpetual shades
> Of darkness, would congeal the living blood,
> Did not the arctic tract spontaneous yield
> A cheering purple berry, big with wine."

In the northern parts of Sweden and Norway, and in Lapland, even to the North Cape, the cloud-berry grows in such abundance as to be an article of extensive commerce. Great quantities of it are sent every autumn to the Swedish capital, and to the southern parts of that country, where they are used in a variety of ways; and, in fact, it forms the principal fruit that they have.

Dr Clarke notices the value of this berry in his travels:—"In woods, and moist situations near the river, we found the *rubus chamæmorus* still in flower. The Swedes call it Hiorton; the Laplanders give it the name of Latoch; the inhabitants of Westro-Bothnia call it Snotter; and in Norway its appellation is Multebæar. The same plant is found upon some of the highest mountains, and in some of the peat-bogs of the north of England; on which account, perhaps, it is called cloud-berry in our island; but it is not likely that its fruit ever attains the same degree of maturity and perfection in Great Britain as in Lapland, where the sun acts with such power during the summer. Its medicinal properties have certainly been overlooked, owing, perhaps, either to this circumstance, or to its rarity in Great Britain. The fruit is sent in immense quantities, in autumn, from all the north of the gulf of Bothnia to Stockholm, where it is used for sauces, and in making vinegar."

Our English traveller, as appears by the following passage, was under greater obligations to the cloud-berry than the Swedish naturalist to the other species of Arctic fruit: "Mr Grape's children came into the room, bringing with them two or three gallons of the fruit of the cloud-berry. This plant grows so abundantly near the river, that it is easy to gather bushels of the fruit. As the large berry ripens, which is as big as the top of a man's thumb, its colour, at first scarlet, becomes yellow. When eaten with sugar and cream, it is cooling and delicious, and tastes like the large American hautboy-strawberries. Little did the author dream of the blessed effects he was to experience by tasting of the offering brought by these little children, who, proud of having their gifts accepted, would gladly run and gather daily a fresh supply, which was as often blended with cream and sugar by the hands of their mother, until at last he perceived that his fever rapidly abated, his spirits and his appetite returned, and, when sinking under a disorder so obstinate that it seemed to be incurable, the blessings of health were restored to him, where he had reason to believe he should have found his grave. The symptoms of amendment were almost instantaneous after eating of these berries."

THE STRAWBERRY *(fragraria vesca)*. This well known berry has received the name *fragraria* from its delightful flavour. No vegetable production of the colder latitudes, or which can be ripened in those latitudes without the assistance of artificial heat, is at all comparable with the strawberry in point of flavour; and if the soil and situation be properly adapted to it, the more cold the climate, indeed the more bleak and elevated, the more delicious is the berry. The fine *aroma* of the strawberry is not quite so evanescent as that of the raspberry; but it is by no means durable; and the berries can be had in absolute perfection only when taken from the plants, and in dry weather, for a very slight shower will render the strawberry comparatively flavourless. The soils and situations in which the strawberry and the raspberry come to the greatest perfection are the very opposites of each other. The strawberry, in all its varieties, certainly in all the finest of them, is a sort of rock plant; and soil which contains a good deal of decomposed rock, more especially if that rock be greenstone, or any other containing much clay, produces fruit of the finest flavour. The places where the strawberry is the finest, as raised for the market, and of course as produced at the least expense of artificial culture, are probably Edinburgh and Dundee, at both of which the soil is of the description mentioned.

The strawberry is very widely diffused, being found in most parts of the world, especially in Europe and America. Its common name is peculiar to England, and is supposed to have been derived from the custom of laying straw under strawberry plants when their fruit begins to swell. Others, however, contend it is *stray*berry, from its trailing along the ground. The gardener of Sir Joseph Banks revived this old method with advantage. The fruit was known in London, as an article of ordinary consumption, in the time of Henry VI. In a poem of that age, called "London Lyckpeny," by John Lidgate, who died about 1483, we find the following lines:—

> "Then unto London I dyde me hye,
> Of all the land it bearyeth the pryse;
> 'Gode pescode,' one began to cry—
> 'Strabery rype, and cherrys in the ryse.'"

It is mentioned by Hollinshed, and the fact has been dramatised by Shakspeare, that Glo'ster, when he was contemplating the death of Hastings, asked the bishop of Ely for strawberries:

> "My lord of Ely, when I was last in Holborn,
> I saw good strawberries in your garden there."

The cultivation of the strawberry is very extensive in the neighbourhood of London. The largest quantities, and the finest sorts, are grown at Isleworth and Twickenham.

The common wood strawberry (which was probably the earliest cultivated) has the leaves rather small, the runners (at the joints of which the new plants are produced) slender, and often of a purple colour. The fruit is small, and generally red, but without much flavour, owing to its being shaded from the sun. When brought out of the shade, or in countries where the influence of the sun is more powerful, both its size and flavour are very much improved; and though not the handsomest, it becomes far from the worst of the cultivated sorts. There is a variety of the wood strawberry a good deal paler, both in the leaves and the fruit, than the one now mentioned, which also ripens later in the season; but it is by no means productive, and is accordingly not much cultivated.

The Alpine strawberry is, in its native situation, a more vigorous plant, and produces larger and more highly flavoured fruit than the common one of the woods. It is often much darker in the colour than any of the other strawberries; and when it is so, the flavour has a sharpness bordering upon austerity. Still, however, it is an excellent fruit; and it has this advantage, that it continues bearing from June until stopped by the frost; and, in very open seasons, fruit has been gathered from it at Christmas.

The Hautbois was the first known of the larger variety of strawberry. Its history has never been well ascertained, though it is generally believed to be the mountain strawberry of Bohemia, and to have been first improved by cultivation in France. The hautbois is very productive; and the fruit is highly flavoured, with a peculiar kind of perfume; but some care is necessary in order to prevent the plants from degenerating. The name of this strawberry is probably derived from the circumstance of the scape which bears the fruit standing higher than the leaves, and, consequently, being called hautbois (high wood). In the old gardening books it is written hautboy.

In the early part of the last century, the Alpine strawberry of Chili was introduced into the Royal Gardens at Paris, and from thence found its way over many parts of Europe. It grew to an immense size, and had a finer colour than the hautbois; but in the southern countries of Europe it was soon neglected, because it ran greatly to leaves, produced comparatively little fruit, and what it did produce was deficient in flavour. The "old scarlet strawberry," which was an original introduction from North America, has been an inhabitant of our gardens for nearly two hundred years. The "old black strawberry," an unproductive sort, has been long known in England. The "Chinese" and the "Surinam" strawberries are of considerable antiquity amongst us. The "old pine, or Carolina," has been cultivated and highly prized by the English growers.

Since attention began to be paid to the culture of strawberries, the number of varieties has been greatly increased. The British strawberries are divided into scarlet, black, pine, hautbois, green, alpine, and wood, according to a classification in a valuable paper in the sixth volume of the Horticultural Transactions. Of these varieties the pine is the most esteemed. It is a native of Louisiana and of Virginia. Its colour is a deep red on both sides; and it is the most rich and highly flavoured of all strawberries, constituting the most valuable variety that has yet been discovered.

Strawberry plants multiply spontaneously every summer, as well by suckers from the parent stem, as by numerous runners, all of which rooting and forming a plant at every joint, require only removal to a bed where there is room for them to flourish. Each of these separately planted bears a fine fruit the following season, and will bear in full perfection the second summer. A plantation of the alpine yields fruit the same year that it is made. The wood and the alpine grow readily from seed, and bear a finer fruit than that from offsets. The other kinds, however, are regularly propagated from offsets.

Strawberries require a deep soil, and manure not much rotted. A bank, exposed to the sun, or freely exposed beds, are most suited for all the sorts, except the alpine and wood, which require shaded situations. They may either be planted in beds or borders. The plants are to be kept clean, and the suckers cut away frequently. The whole plants are to be renewed every fourth or fifth year; some, however, renew the plants every year. A strawberry wall may be made of loose stones or bricks, three to four feet wide, and sloping upwards two to three feet; the interior is filled up with soil, and the strawberries planted outside.

CHAP. XXXV.

THE GRAPE, MULBERRY, CURRANT, GOOSEBERRY, BARBERRY, &c.

THE GRAPE VINE, *(vitis vinifera.)* This celebrated plant belongs to the natural family *viniferæ*, of which it is the principal and typical genus; and to the class *pentandria*, order *monogynia* of Linnæus. It is a trailing, deciduous, hardy shrub, with large, elegantly shaped leaves, and producing flowers in the form of a raceme, of a greenish white colour, and fragrant odour; appearing in the open air in this country in June, and the fruit, which is of the berry kind, attains such maturity as the season and situation admit by the middle or end of September.

The grape is of a globular, ovate, or oblong

shape, varying in colour according to the varieties, being green, white, red, yellow, and deep purple; the skin is smooth, the pulp of a sweet luscious flavour; the pulp incloses from three to five heart-shaped small stones or seeds; some varieties, however, as the ascalon, produce no seeds. The weight of the grape depends not only on its size, but the thickness of its skin, and texture of the fleshy pulp. The lightest are the thin skinned, juicy sorts, as the sweet water, and muscadine; the largest of these measure an inch and a half in circumference. A single vine in a large pot, or grown as a dwarf standard, in the manner practised in the vineyards of the north of France, generally produces from three to nine bunches; but by superior management, in gardens in England, the number of bunches is prodigiously multiplied: vines in pots have ripened twenty bunches each plant the first year. A Hamburgh vine in Hampton Court gardens, produced the astonishing number of 2200 bunches, averaging one pound each, or in all, nearly a ton.*

The vine is a very long lived plant, indeed, in warm climates, the period of its existence is unknown. It is supposed to equal, if not surpass the oak in this respect. Pliny speaks of a vine which had existed six hundred years; and there are vines in Burgundy, said to be upwards of four hundred years old. In some parts of Italy there are vineyards which have been in a flourishing state for upwards of three centuries, and there a vineyard of one hundred years' duration is reckoned young. The extent of the branches of the vine, in certain situations and circumstances, is commensurate with its produce and age. In the hedges of Italy, and the woods of America, they are found overtopping the highest elm and poplar trees; and in England, one plant trained against a row of houses in Northallerton, covered a space of one hundred and thirty-seven square yards; and that at Valentines, in Essex, above one hundred and forty-seven square yards. The size to which the trunk or stem sometimes attains in warm climates, is such as to have afforded planks fifteen inches broad. The timber of the vine is of great durability.

The grape seems to have been one of the earliest cultivated fruits. We read in Genesis that Noah planted a vineyard, and wine is mentioned as a beverage among the earliest nations of the world. Yet we are to this day ignorant of the native country of the vine. The oldest profane writers ascribe its introduction to their gods. According to the tradition of the Egyptians, Osiris first paid attention to the vine, and instructed other men in the manner of planting and using it. The inhabitants of Africa ascribe the same gift to the ancient Bacchus. We find mention of the fermented juice of the grape as early as that of its cultivation. Wine was among the first oblations to the Divinity. "Melchizedek, king of Salem, brought forth bread and wine, and he was the priest of the Most High God." We may trace through all the most ancient records of the human race, a conformity between the chief articles of subsistence, and the sacrifices to heaven. In the earliest ages, herbs, fruits, and plants were alone offered up; the first libations were made with water, wine then being unknown; gradually honey, milk, oil, wine, and corn were added; and at last, when animals were rendered domestic, and formed the principal nourishment of man, the kid and the ox were laid upon the altar.

"The vine," says Humboldt, "which we now cultivate, does not belong to Europe; it grows wild on the coasts of the Caspian sea, in Armenia, and in Caramania. From Asia it passed into Greece, and thence into Sicily. The Phoceans carried it into the south of France; the Romans planted it on the banks of the Rhine. The species of *vites*, which are found wild in North America, and which gave the name of the land of the vine *(Winenland)* to the first part of the New continent which was discovered by Europeans, are very different from our *vitus vinifera.*" It is a popular error that the grape vine was common to both continents.

It has been said that the vine was introduced into England by the Romans; but if so, it could not have been till near the close of their influence, for Tacitus mentions that it was not known when Agricola commanded in the island. At the invasion of the Anglo-Saxons, however, when the country had been under the Roman dominion four hundred years, and had received, during that long period, all the encouragement which that people gave to the agriculture of their provinces, the vine, without doubt, was extensively cultivated. Vineyards are mentioned in the earliest Saxon charters, as well as gardens and orchards, "and this was before the combating invaders had time or ability to make them, if they had not found them in the island." In the Cottonian Manuscripts, in the British Museum, there are some rude delineations in a Saxon calendar, which, in the month of February, represent men cutting or pruning trees, some of which resemble vines. King Edgar, in an old grant, gives the vineyard, situate at Wecet, as well as the vine-dressers. In Domesday Book, vineyards are noticed in several counties. According to William of Malmesburgh, who flourished in the first half of the twelfth century, the culture of the vine had in his time arrived at such perfection within the vale of Gloucester, that a sweet and palatable wine, "little inferior to that of France," was made there in abundance. In the thirteenth and fourteenth centuries, almost

* Loudon.

every large castle and monastery in England had its vineyard. The land on the south side of Windsor Castle, now a pleasant green lawn, running from the town under the castle wall, was a vineyard, of which a particular account may be seen in the Archæologia. At this period, wine was made in England in considerable quantities; and yet the importation of foreign wines was very large. In the year 1272, London imported 3799 tons; Southampton and Portsmouth, 3147; and Sandwich, 1900. In the time of Edward III., a trade in Rhenish wine was carried on between Hull and the ports of the Baltic. The vineyards were, probably, continued till the time of the Reformation, when the ecclesiastical gardens were either neglected or destroyed; and about this period, ale, which had been known in England for many centuries, seems to have superseded the use of wine as a general beverage.

This arose from the better cultivation of the country. Under the feudal tenures, when the serfs were often suddenly compelled to follow their lords to battle, husbandry, particularly the growth of grain, was fearfully neglected; and sometimes the most dreadful famines were the result. The prices of wheat occasionally fluctuated from ten shillings to twenty pounds per quarter. But when just principles of tenancy were established, so that the occupier of the land could be sure of appropriating to himself a fair proportion of the fruit of his labour, agriculture began to flourish. The cultivation of hops was revived or introduced about the end of the fifteenth century. All these circumstances—the decay of the vineyards, the encouragement to the growth of grain, and the culture of hops, gradually tended to supersede the demand for wine, by offering a beverage to the people which was cheaper, and perhaps as exhilarating.

We are told,* that on the southern coast of Devonshire, possessing the mildest temperature of the English counties, there are still two or three vineyards, from which wine is commonly made. A vineyard at the castle of Arundel, on the south coast of Sussex, was planted about the early part of the last century, and of the produce there are reported to have been sixty pipes of wine in the cellars of the Duke of Norfolk, in 1763. This wine is said to have resembled Burgundy; but the kind of grape and the mode of culture have not been particularly recorded. Whatever may have been the condition and qualities of the early English grapes employed in making wine, we know that they must have been ripened by the natural temperature of the climate, as artificial heat was not resorted to for the ripening of grapes till the early part of the last century; and then the heat was applied merely to the other side of the wall on which the vines were trained: nor is it till about the middle of the same century that we have any account of vines being covered with glass. Professor Martyn is an advocate for the renewal of grape culture in this country for wine. For that purpose he recommends that the vines should be trained very near the ground, he having found that, by this method of training, the berries were much increased in size, and also ripened earlier. The same method is pursued in the northern part of France, where it is found to be successful.

The culture of the grape, as an article of husbandry, extends over a zone about two thousand miles in breadth, that is, from about the twenty-first to the fiftieth degree of north latitude; and reaching in length from the western shores of Portugal, at least to the centre of Persia, and probably to near the sources of the Oxus and the Indus. Farther north than that, it does not ripen so as to be fit for the making of wine; and farther south, it seems to be as much injured by the excessive heat. The best wines are made about the centre of the zone; the wines towards the north being harsh and austere, and the grapes towards the south being better adapted for drying and preserving as raisins. Thus, in Spain, while the wine of Xeres, in the Sierra Morena (the real Sherry,) is an excellent wine, and while that of the ridge of Apulxarras, in Granada, is very tolerable, the grapes of the warm shores about Malaga, and in Valentia, are chiefly fit only for raisins. So, also, while the slopes of Etna, and those of the mountains in Greece, furnish some choice vines, the grapes upon the low shores in those countries have also to be dried. It should seem, that the grapes are always the higher flavoured and the more vinous, the greater the natural temperature under which they are ripened, but that an extreme heat throws the juice into the acetous fermentation before the vinous one has time to be matured. We have an analogous case in the fermentation of malt liquors in this country, which cannot be properly performed in the warm months.

About eight thousand tons of raisins, or dried grapes, are annually imported into England, at a duty of about £160,000. A considerable quantity of undried grapes are also imported, principally from Portugal, in jars, among saw-dust. The value of those so imported is about £10,000. The *currants* of commerce, which are so extensively used in England, and of which about six thousand tons are annually imported into this country, are small dried grapes, principally grown in the Ionian islands.

Laborde, in his account of Spain, gives the following description of the mode of drying raisins: "In the kingdom of Valencia they make a kind of ley with the ashes of rosemary and vine branches, to which they add a quart of

* Library of Entertaining Knowledge.

slaked lime. This ley is heated, and a vessel, full of holes, containing the grapes, is put into it. When the bunches are in the state desired, they are generally carried to naked rocks, where they are spread on beds of the field artimesia, and are turned every two or three days till they are dry. In the kingdom of Granada, particularly towards Malaga, they are simply dried in the sun, without any other preparation. The former have a more pleasing rind, but a less mellow substance; the skins of the latter are not so sugary, but their substance has a much greater relish; therefore, the raisins of Malaga are preferred by foreigners, and are sold at a higher price: to this their quality may likewise contribute; they are naturally larger, and more delicate, than those of the kingdom of Valencia."

A vineyard, associated as it is with all our ideas of beauty and plenty, is, in general, a disappointing object. The hop plantations of our own country are far more picturesque. In France, the vines are trained upon poles, seldom more than three or four feet in height; and "the pole-clipt vineyard" of poetry is not the most inviting of real objects. In Spain, poles for supporting vines are not used; but cuttings are planted, which are not permitted to grow very high, but gradually form thick and stout stocks. In Switzerland, and in the German provinces, the vineyards are as formal as those of France. But in Italy is found the true vine of poetry, "surrounding the stone cottage with its girdle, flinging its pliant and luxuriant branches over the rustic viranda, or twining its long garland from tree to tree." It was the luxuriance and the beauty of her vines and her olives that tempted the rude people of the North to pour down upon her fertile fields.

In Greece, too, as well as Italy, the shoots of the vines are either trained upon trees, or supported, so as to display all their luxuriance, upon a series of props. This was the custom of the ancient vine-growers; and their descendants have preserved it in all its picturesque originality. The vine-dressers of Persia train their vines to run up a wall, and curl over on the top. But the most luxurious cultivation of the vine in hot countries is where it covers the trellis-work which surrounds a well, inviting the owner and his family to gather beneath its shade. "The fruitful bough by a well" is of the highest antiquity.

Although the vine bears at three or four years plentifully, it is said that vineyards improve in quality till they are fifty years old. Pliny mentions a vine which had attained the age of six hundred years. In France and Italy there are entire vineyards still in existence, and in full bearing, which were in the same condition at least three centuries ago, and have so continued ever since. The slender stems of ordinary vines, when they have attained a considerable age, are remarkably tough and compact; and the timber of the very old ones in foreign countries, which is occasionally of size enough for being sawn into planks, and being made into furniture and utensils, is almost indestructible. Strabo mentions an old vine which two men could not embrace. A single vine plant, already alluded to, which was trained against a row of houses at Northallerton, covered, in 1785, one hundred and thirty-seven square yards. It was then about a hundred years old, and it increased in size afterwards; but it is now dead. In 1785, the principal stem of this vine was about fifteen inches in diameter.

The varieties of the grape are exceedingly numerous. Tusser, in 1560, mentions only white and red grapes; Parkinson, in the following century, gives a list of twenty-three sorts. In modern times, a great profusion of varieties have been obtained by sowing the seeds of grapes ripened in this country. The varieties are thus classified by Loudon:

Red, purple, and *black grapes, round-shaped*, including the early black. Miller's Burgundy, Muscadine, Frontignan, Lombardy, &c.

Oval, dark red, purple black, including black cluster, black muscadel, claret, Alicant, &c.

Round white, including white Muscadine, sweet-water, chasselas, white Frontignan.

Oval white, white muscat of Alexandria, white Hamburgh, white Tokay, Alexandrian ciblet.

Rose-coloured, red and grizzly Frontignan, Lombardy, &c.

The vine is propagated from seeds, layers, cuttings, grafting, and inoculation; by seed, for the sake of obtaining new varieties; by layers, to get strong showy plants the first year; by cuttings, for economy in management, and to get plants with top proportioned to their roots; and by grafting and inoculation, for various useful, and curious purposes.

The vine will thrive in any soil that has a dry bottom: in a rich deep soil it will grow with great luxuriance, and produce abundance of large fruit. In dry chalky or gravelly soils, though the quantity and size of the fruit be less, the flavour is higher. The greater part of the vineyards of France are on an argillaceo-calcareous soil, or an argillaceous gravel. The debris of granite and schistose rocks produce vines both of good and bad qualities. The wines produced from chalky soils are weak and colourless, and do not keep well, as champaigne; wines produced from grapes, grown in the ashes of volcanoes, are of excellent quality. Deep retentive clays are least adapted for the production of grapes.

Vines are trained on walls, which should have a south exposure, as espaliers, or as standards. They are liable to the attacks of various insects, particularly to a species of red spider, which burrows in the under side of the leaves.

In vine countries, the grapes which are reckoned best suited for making wine, are not the most agreeable to eat. The wine grapes in France, Italy, and Germany, as well as in Spain and Portugal, are varieties of the black cluster; while the sweet wines, as Constantia, Malmsy, and Madeira, are varieties of the chasselas and muscadine.

Of the variety of the vine called the black Hamburgh, there are several remarkable trees in England, covering a great extent of surface, and bearing (under glass) a profusion of the finest fruit. Of these, among the most celebrated are the Hampton Court vine, and the vine at Valentines, in Essex. The Hampton Court vine, already alluded to, is in a grape-house on the north side of the palace: it covers a surface of twenty-two feet by seventy-two, or 1694 square feet. It is a most productive bearer, having seldom fewer than two thousand clusters upon it every season. In the year 1816, there were at least 2240, weighing each, on the average, a pound; so that the whole crop weighed a ton, and, merely as an article of commerce, was worth upwards of £400. The Valentines vine extends over a greater surface, and has a larger trunk, than that at Hampton Court; but it is not, on the average of seasons, so productive. It has, however, been known to produce two thousand bunches of a pound each.

THE MULBERRY *(morus nigra)*. This tree, more celebrated as affording leaves on which the

125.

The Mulberry.

silk-worm feeds than for its fruit, which is, however, of a very grateful quality, belongs to the class *monœcia*, and order *tetrandria* of Linnæus. It is rather a small tree, and sends off crooked branches, which are covered with a rough brown bark. The leaves are numerous, heart-shaped, serrated, veined, rough, of a bright green colour, and stand upon short foot-stalks. The flowers are male and female upon the same tree, the male being placed in close catkins. The fruit is a large succulent berry, composed of a number of smaller berries, each containing an oval seed, and affixed to a common receptacle. It flowers in June, and its fruit ripens in September. The ripe fruit abounds with a deep violet-coloured juice, which in its general qualities agrees with the other acidulous fruits.

The mulberry tree appears to have formed an object of cultivation at a very early period in the western parts of Asia, and in Europe. The attention there bestowed upon it must have been solely on account of its fruit; for the knowledge of the mode of rearing silk-worms was confined to the people of central and southern Asia till the sixth century. We read in the Psalms that the Almighty wrath destroyed the "mulberry trees with frost;" and this must have been recorded as a remarkable instance of the divine displeasure, for the mulberry is universally known not to put forth its buds and leaves till the season is so far advanced that, in the ordinary course of events, there is no inclement weather to be apprehended. It has therefore been called the wisest of trees; and in heraldry it is adopted as "an hieroglyphic of wisdom, whose property is to speak and to do all things in opportune season." In the history of the wars of David with the Philistines, the mulberry tree is mentioned as a familiar object. Pliny says of it, somewhat questionably, that "when it begins to bud, it despatches the business in one night, and that with so much force, that their breaking forth may be distinctly heard."

In this country there are many old mulberry trees of large dimensions, and remarkable also for the quantity of fruit they bear. It is probable that some of these old trees were planted at the latter end of the sixteenth and the beginning of the seventeenth centuries; for James I. endeavoured to render the cultivation of the tree general, in the same way that Henry IV. had laboured to introduce it in France. The first mulberry trees of England are said to have been planted at Sion House, the seat of the duke of Northumberland, in 1548; and the trees, though decayed in the trunk, still bear fruit. Mulberry gardens were common in the seventeenth century in the neighbourhood of London; but either from the climate, or the prejudices of the people, the growth of silk never prospered. The mulberry is distinguished for the facility with which it may be propagated. A cutting from a tree which has borne fruit will soon become a vigorous plant. It is recorded that, at Bruce castle, at Tottenham, an immense branch being torn off by the wind from an old mulberry tree, about forty years ago, the branch was thrust into the ground, and flourished. It is now a handsome

tree. That part of the trunk of the old tree which lost the branch is covered with lead. But at the same time, the mulberry has been also remarkable for not producing fruit till the trees have acquired a considerable age; and this circumstance has materially affected its cultivation as a fruit tree. The same objection has applied to the walnut. Recent experiments, however, have shown that, by proper culture, both the mulberry and the walnut may be made to produce fruit at three years old.

The sort principally cultivated for fruit is the black mulberry *(morus nigra)*, although the fruit of the white, Tartarian, red, and Pennsylvanian species (of the white particularly) "are of sufficient consequence to merit a place in a list of edible fruits." The black mulberry is a hardy tree; and as the berries are abundant, and of very wholesome quality, while the wood makes excellent timber, and the leaves are adapted for the feeding of silk-worms as well as those of the white mulberry, it deserves more attention than it generally receives.

The mulberry is the latest tree to put forth its leaves; and it drops every leaf on the first night of severe frost. Some trials have been made of mulberries trained against a south wall, and the result has been a great improvement in the fruit.

The mulberry is generally propagated by layers, cuttings, grafting, and occasionally from seed. It thrives best in a rich light earth, with sufficient depth of soil, and an open sunny situation. A full grown tree will afford fruit sufficient for the supply of a large family.

The Currant *(ribes)*. The currant and gooseberry form a natural family, nearly allied to the cacti, and denominated *grossulariæ*. They belong to the class *pentandria*, and order *monogynia* of Linnæus.

The Red Currant (ribes rubra) is a native of the northern parts of Europe, and is found in hedges and woods in England. The berries of this shrub, in its wild state, are uniformly red; cultivation has produced the white variety common in our gardens. According to Professor Martyn, the currant was unknown to the ancient Greeks and Romans, as in the south of Europe it has not an appropriate name to this day. Mr Aiton, in his Hortus Kewensis, is of opinion that the currant is indigenous to Britain. Its name, however, being the same as the small seedless grape of the Levant *(Corinth)*, is against this theory; and in "Dodoen's History of Plants," translated in 1578, it is called "the red beyond-sea gooseberry." The white, having the most delicate flavour, is most in request for the dessert. The red is principally used in the preparation of jellies; and the white is converted into wine, which, with fine fruit, and using the juice alone, or only with sugar, without any mixture of spirits or of water, may, when kept to a proper age, be made to equal some of the inferior wines from the grape. For pastry, the currant is amongst the most valuable of the British fruits, being easily preserved, and growing in sufficient abundance, on account of its hardiness, to offer a cheap luxury to the humblest classes. This bush forms the principal ornament of some of those neat cottages which are so peculiarly characteristic of England. In parts of the country where it is the custom to train the currant against the walls of the house, its rich dark leaves, and its brilliant fruit, growing over the latticed window, offer almost as pleasing a picture as the vines of Italy.

The Black Currant (ribes nigra) is a native of most parts of Europe, and abounds in the woods of Russia and Siberia. It is supposed to be a native of Britain; or, at all events, the period of its introduction is unknown. The berries are larger than those of the red or the white, but they are not so juicy; and the crop upon a single bush is less abundant. Their taste is peculiar, and to some disagreeable. They are supposed to have medicinal qualities which do not belong to the other species of currants. They answer well for tarts and puddings; and can be made into a very pleasant jelly, which, in village pharmacy, is recommended in cases of sore throat; and they make a very good *rob* (souring) for flavouring liquors. The leaves of the black currant have a strong taste, especially in the early part of the season; and if a small portion be mixed with black tea, the flavour is changed to one resembling that of green. On this account it is suspected that those leaves are pretty extensively used in the adulteration of tea,—the coarser sort of black being coloured green by moistening it with vinegar, laying it upon heated plates of copper till it be shrivelled into small balls, and mixing it with black currant leaves, which have also been shrivelled by heat. If this process has been employed, the tea will discolour a silver spoon.

There are thirty-five varieties of the currant specified in the fruit catalogue of the Horticultural Society; but there is perhaps no class of fruits in which so much ignorance exists as to the merits and difference of the varieties. It is stated to be impossible to obtain the different kinds with certainty from the nurseries.

The Gooseberry *(ribes grossularia)*. Some have derived the name gooseberry from gorse-berry, or the resemblance of the bush to gorse; others from the berry being used as a sauce to young geese. In Cheshire, and some of the neighbouring counties of England, it was called fea, or feverberry; in Norfolk this name is abbreviated to *feabes*, pronounced *thapes;* carberry is another English name. In France it is called *groseille;* in Scotland, sometimes *grozet.* It is

a native of several parts of Europe, and abounds in the valleys in copse woods, where it produces a small green hairy berry of high flavour. In England, if not a native, it is now naturalized in various places, and grows wild in old walls, ruins, and in woods. It is cultivated in Lancashire in greater perfection than in any other part of Britain; and next to Lancashire, the climate of the Lothians, and some of the northern counties of Scotland seem to suit this plant. In France it is neglected; in Italy and Spain it is scarcely known. It was early a favourite fruit, and still continues to be so, in all parts of Britain. In the time of Tusser, who flourished in the reign of Henry VIII., this fruit was cultivated. He says:—

> "The barbery, respis,* and gooseberry too,
> Look now to be planted as other things do."

In the south of Europe it is small, tasteless, and neglected; and though it grows to a large size in the warmer parts of England, its flavour there is very inferior to that which it has in Scotland. Even in that country, the flavour seems to increase with the cold; for if there be warmth enough for bringing gooseberries to maturity and ripening them, the farther north they are grown the better. The market-gardeners about Edinburgh pay much attention to the culture and kinds of their gooseberries; but they are never equal in flavour to those which are grown at Dundee, Aberdeen, or Inverness.

In England, the Lancashire gooseberries are the finest in appearance. They are very large; but still their flavour is far inferior to that of the Scotch. Perhaps the inferiority of the English berries may be in great part owing to the large sorts that are cultivated,—the finest, even in Scotland, being those that are of a middle size.

Gooseberries are of various colours—white, yellow, green, and red; and of each colour there are many sorts. If, however, any particular sort be wished to be preserved, it must be done by cuttings, because the seeds of any one sort are apt to produce not only all the known sorts, but new ones.

The gooseberry plant, under favourable circumstances, will attain a considerable age, and grow to an immense size. At Duffield, near Derby, there was, in 1821, a bush ascertained to have been planted at least forty-six years, the branches of which extended twelve yards in circumference. At the garden of the late Sir Joseph Banks, at Overton Hall, near Chesterfield, there were, at the same time, two remarkable gooseberry plants, trained against a wall, measuring each upwards of fifty feet from one extremity to the other.

* Raspberry.

The yellow gooseberries have, in general, a more rich and vinous flavour than the white; they are, on that account, the best for the dessert, and also for being fermented into wine. When the sort is choice, and well picked, so that none of the fruit is damaged, or over or under ripe, and when the wine is properly made, it often puzzles an unpractised taste to distinguish the wine of the best yellow gooseberries from champaign. It has the flavour and colour, and it mantles like the best of the foreign wine.

Generally speaking, the green gooseberries are inferior to the yellow, and even to the white; many of them, however, run large, and are used for the sake of appearance. Large gooseberries in general, and large green ones in particular, are thick in the husk, and contain less pulp than those of a smaller size; while the flavour is in general rich in proportion to the thinness of the husk. Some of the larger greens, especially those that are smooth, gourd-shaped, and of a brownish tinge, are almost tasteless, or even disagreeable.

The red gooseberries are very various in flavour, but are commonly more acid than the others. The same may be said of most other fruits; and it agrees with the well known fact, that acids change the vegetable blues to red. In many fruits, and the gooseberry in particular, the amber colour is accompanied by the richest vinous flavour, while the white tends to insipidity. When the green is deep and pure, sweetness seems to be the leading characteristic, as in the Gascoigne gooseberry, the green-gage plum, and the small green summer pear, known in Scotland by the name of the "Pinkey green." Among the red gooseberries there are, however, many exceptions. Some of the older and smaller red sorts (especially that known by the name of the "old ironmonger") are very sweet. It would be unavailing to fix upon any particular kind of gooseberry as the best, as every year produces new varieties. In the fruit catalogue of the Horticultural Society there are nearly two hundred kinds enumerated, of which about a hundred and fifty are the large Lancashire gooseberries.

The cultivation of gooseberries forms a pleasing occupation amongst the manufacturers of that part of the kingdom; and the custom has doubtless a tendency to improve both the health and the morals of the people. Any pursuit which makes men acquainted with the peculiarities of vegetable economy, in however small a degree, has a beneficial effect upon the heart and understanding; and it is certainly better for weavers and nailers to vie with each other in raising the largest gooseberries, than in those games of chance or cruel sports, to which the few leisure hours of the working classes are too often devoted.

Both currants and gooseberries are of very easy culture. They may be raised from slips, which is the usual mode of perpetuating varieties, or by all the other methods used in propagating shrubs and trees. New varieties are obtained from seed. Any good soft soil is suitable to them. A moist soft soil is most favourable to the gooseberry. The bushes require a pruning twice a year. The gooseberry plant of four years old produces the largest and finest fruit; afterwards the fruit becomes smaller, though it increases in quantity. The fruit is produced not only on the shoots of last summer, and on shoots two or three years old, but also on spurs arising from the older branches along the sides. Many insects attack the gooseberry, such as the aphis, caterpillar, and saw fly. The currant moth, *abraxas grossulariata*, is a middle-sized moth, white, with numerous black spots. It deposits its eggs on the under side of both currant and gooseberry leaves. The gooseberry moth is rather smaller, and feeds on the leaves of both shrubs. The saw fly, *nematus ribesii*, is still more destructive to the gooseberry. Early in March this small fly, of a greenish colour, shagreened with deep black tubercles, deposits a string of minute eggs along the under ribs of the lower leaves. A single fly will fill the ribs of many leaves. In ten days those eggs will be hatched into caterpillars; then after feeding voraciously on the leaves for about ten days more, they drop unto the ground, and change into the chrysalis state. In this state they remain for fourteen or fifteen days, when another fly is produced, which mounts up and deposits a fresh progeny among the leaves. In this way the bushes of a whole garden are stripped of their foliage in a few weeks. The best preventive is to hand pick the bushes early in the season, and destroy all the eggs and flies that can be found. Digging up the earth about the roots of the bushes frequently, but especially in autumn, previous to the winter frosts, is also advisable. Sprinkling with lime-water, tobacco juice, and other fluids, has also been recommended.

The Barberry, *(berberis vulgaris.)* Natural family *Berberideæ. Hexandria monogynia*, Linn.

This is an ornamental as well as useful shrub. When covered with flowers in spring, or fruit in autumn, it forms a pleasing object. The leaves are of a yellowish or bluish green, and gratefully acid to the taste; the odour of the flowers is pleasant at some distance, though too strong, and offensive when near.

This shrub is a native originally of the eastern countries, though it is now found in most parts of Europe, where it thrives best upon light and chalky soils. It grew formerly wild, in great quantities, in the hedgerows of England, but has been universally banished, from a general belief that its presence is injurious to the growth of corn. Du Hamel, Broussonet, and other scientific writers, treat this belief as a vulgar prejudice. It should, however, be remarked, that the fructification of the barberry is incomplete, unless the stamens be irritated by insects, when the filaments suddenly contract in a most remarkable manner towards the germ. The flowers are, therefore, by a beautiful arrangement of nature, peculiarly attractive to insects; and thus the barberry may become injurious to neighbouring plants. The berries grow in bunches, and are so very acid, that they are seldom eaten; but with the requisite quantity of sugar, they make an excellent jelly. They are used also as a sweet meat, and put into sugar plums or comfits. The fruit is sometimes used in medicine, as a mild and cooling refrigerant. The roots boiled in an alkaline ley, yield a yellow colour, used in Poland for dying leather. The bark also yields a yellow dye.

Cattle, sheep, and goats browse on this shrub, and numerous kinds of insects are remarkably fond of the flowers and leaves.

The Elder Berry, *(sambucus nigra.) Pentandria trigynia* of Linn.

The elder is a native of this country; is very generally diffused; grows with singular rapidity, though it never arrives at great size; and endures the most bleak situations, though in the northern parts of Scotland the fruit seldom ripens. The berries of the elder are fermented into a wine, which, when spiced and drunk warm, is a pleasing winter beverage. They are supposed to contain a portion of the narcotic principle. The black variety is chiefly cultivated for this purpose; but the berries of the yellow and green are also applicable to wine making.

The elder tree furnishes the unscientific practitioner of the healing art with many of the most approved remedies; and perhaps not without reason. Boerhaave, the great physician, is said to have regarded the elder with such reverence, for its medicinal virtues, that he sometimes took off his hat in passing a tree of this species. The leaves are narcotic, purgative, and acrid; the flowers in decoction are diaphoretic, and are used to give a flavour to vinegar. The French strew them among casks of apples, to which they communicate an agreeable odour.

The berries are said to prove poisonous to poultry, and especially to turkies.

126.

The Blaeberry.

The Bilberry, or Blaeberry, *(vaccinium myrtillus.)* This berry grows plentifully on heaths and waste places; and is very hardy. It is a handsome berry, with a delicate bloom when in perfection; but it is tender, and, when kept for some time, ferments. In some of the pine forests in Scotland it grows to the height of three

feet; and there are places where the pedestrian can pull handfuls of berries as large as the common black currant of the gardens.

Two other species of *vaccinium*, the black whortleberry, and the red (the cranberry) are common enough in some parts of this country. One, if not both of these, grows most readily in moist situations, such as the dry patches in peat-bogs. Tusser mentions "hurtil-berries" amongst the cultivated fruits of his time. These were, perhaps, confounded with the fruit of the brambles. "Dewberries" (though supposed by some to be gooseberries) were formerly amongst the delicacies of fruit, if we may judge from the celebrated passage in Midsummer's Night's Dream:—

> "Feed him with apricocks and dewberries,
> With purple grapes, green figs, and mulberries."

The *Red Cranberry, (vaccinium vitis Ideæ,)* of which the berries are excellent, has borne fruit abundantly under cultivation. The berries of the Pennsylvanian *vaccinium* are very ornamental. This genus of berries is very abundant in North America, and also in the northern parts of Russia.

The *American Cranberry (vaccinium macrocarpon,)* forms a considerable article of commerce; and, as does not appear to be the case with some others of the genus, it may be cultivated to advantage on the margins of ponds, and in other moist situations. The importation of cranberries to this country is about 30,000 gallons annually, the duty being sixpence per gallon. This species has been grown in England.

An interesting account of its culture and produce is given by Sir Joseph Banks, in the Horticultural Transactions. In one year, from a bed of about eighteen feet square, three and a half Winchester bushels of berries were produced, which, at five bottles to the gallon, gives 140 bottles, each sufficient for one cranberry pie.

Wherever there is a pond, observes Neill, the margin may at a trifling expence be fitted for the culture of this plant, and it will continue productive for many years. All that is necessary is to drive in a few stakes two or three feet within the margin of the pond, and to place some old boards within these, so as to prevent the soil of the cranberry bed from falling into the water. Then to lay a parcel of small stones or rubbish in the bottom, and over it peat or bog earth, to the depth of about three inches above, and seven inches below the usual surface of the water. In such a situation the plants grow readily; and if a few be put in they entirely cover the bed in the course of a year or two, by means of their long runners, which take root at different points. From a very small space a very large quantity of cranberries may be gathered, and they prove a remarkably regular crop, scarcely affected by the state of the weather, and not subject to the attacks of insects. The cranberry will also succeed when planted as an edging to any pond, provided some bog earth be placed for its roots to run in; or if a bed of bog earth be sunk in any shady situation, so as its surface may be a few inches below the general level for the sake of retaining water, the plant will thrive well, and being regularly watered in the driest weather, produces abundant crops.

THE CROW BERRY, *(empetrum nigrum.) Diœcia triandria*, Linn.

This humble plant, in appearance resembling some of the mosses, derives its generic name from growing on rocks, and elevated stony mountains. The berry is jet black; and hence probably the common name of crow berry. It is common in all the northern parts of Europe, in elevated situations, on dry, barren, moorish, or boggy soils; and is more patient of cold, bleak atmospheres, than even the common heath. The berries have a slight subacid taste, and are eaten by children in the Highlands. The Russian peasants eat them; and the Kamchatdales gather great quantities of them to boil with their fish, or to make a sort of pudding, with the roots of their lilies; wild game especially grouse, feed on them. They afford a dark purple dye; and boiled with fat, are used for imparting a black colour to otter and sable skins.

CHAP. XXXVI.

THE ORANGE, LEMON, LIME, CITRON, SHADDOCK, POMEGRANATE, FIG, OLIVE, &C.

THE natural family *Aurantiaceæ*, or *Hesperideæ*, contains some of the most beautiful and important of exotic fruits. The family belongs to the class *polyadelphia*, and order *polyandria* of Linnæus.

The common character of the *citrons* or orange family, is that of low evergreen trees, with ovate or oval, lanceolate, entire, or serrated leaves. On the ungrafted trees, and those growing in a natural state, there are frequently found axillary spines. There is a structure of the petiole of the leaf, which serves to distinguish the species. Thus, in the orange and shaddock the petiole is winged, producing a marked form of the leaf, as seen in the wood cut, 127.

In the citron, lemon, and lime, the petiole is naked. The flowers appear in peduncles, axillary or terminate, and one or many flowered: the citron and lemon have ten stamens, the orange more. The fruits are large berries, round or oblong, and generally of a yellow colour. In the

orange and shaddock, the shape is spherical, or rather an oblate spheroid, with a red or orange coloured rind; in the lime spherical, with a pale rind; in the lemon oblong, rough, with a nipple-like protuberance at the end; in the citron oblong, with a very thick rind. There is a peculiarity in the fruit of all this tribe. The rind or external pericarp, is of a soft spongy texture, containing but little juice or sap of any kind in its substance; but the external surface is covered or tuberculated over with little glands, that secrete a volatile oil, which is very inflammable and acrid. According to Decandolle, the fruit consists first, of a thick valveless indehiscent coat, which is most likely to be considered a continuous torus; secondly, of several carpella, verticellate around an imaginary axis, often separable without laceration: membranous, and either containing seeds only, or filled with pulp lying in innumerable little bags, proceeding from the inner coats of the cells.

The flowers of this tribe are deliciously fragrant, and the fruits almost all eatable. The wood is particularly close grained.

The golden apples of the heathens, and the forbidden fruit of the Jews, are supposed to allude to this family, though it is remarkable that we have no authentic records of any species of citrus having been known to or cultivated by the Romans.

It is very difficult to determine what is a variety, and what a distinct species in this family. Four species are, however, commonly enumerated —the orange, the lemon, the citron, and the shaddock. Of these there are a great many varieties.

The orange family are originally natives of the warmer parts of Asia, from whence they have been introduced, and naturalised in the southern counties of Europe, in the West India islands, and the tropical parts of America. They will even grow in the open air in the warmer counties of England. In warm climates they continue flowering during nearly all the summer, and the fruit takes two years to come to maturity, so that for a considerable period of each year, a healthy tree has every stage of the production, from the flower bud to the ripe fruit, in perfection at the same time.

The Orange, *(citrus aurantium.)* The orange is a middle sized evergreen tree, with a greenish brown bark, and in its wild state with prickly branches. The leaves are ovate, acute, pointed, and at the base of the petiole are winged. The flowers are white, containing about twenty stamens, and are disposed in clusters of from two to six upon a common peduncle. The fruit is globose, bright yellow, and contains a pulp, which consists of a collection of oblong vesicles filled with a sugary and refreshing juice: it is, besides, divided into eight or ten compartments, each containing several seeds. The principal varieties are the sweet or China orange, the bitter or Seville, the Maltese or red pulped. The box-leaved, willow-leaved, and some others, are cultivated more as curiosities than for use.

The precise time at which the orange was introduced into England is not known with certainty, but probably it may have taken place not long after their introduction into Portugal, which was in the early part of the sixteenth century.

127.

The Orange.

The first oranges, it is stated, were imported into England by Sir Walter Raleigh; and it is added that Sir Francis Carew, who married the niece of Sir Walter, planted their seeds, and they produced the orange trees at Beddington, in Surrey, of which bishop Gibson, in his additions to Camden's Britannia, speaks as having been there for a hundred years previous to 1695. As these trees always produced fruit, they could not, as professor Martyn justly observes, have been raised from seeds; but they may have been brought from Portugal, or from Italy, (the place whence orange trees have usually been obtained,) as early as the close of the sixteenth century. The trees at Beddington were planted in the open ground, with a movable cover to screen them from the inclemency of the winter months. In the beginning of the eighteenth century they had attained the height of eighteen feet, and the stems were about nine inches in diameter; while the spread of the head of the largest one was twelve feet the one way and nine the other. There had always been a wall on the north side of them to screen them from the cold of that quarter, but they were at such a distance from the wall as to have room to spread, and plenty of air and light. In 1738 they were surrounded by a permanent inclosure, like a greenhouse. They were all destroyed by the great frost of the following winter; but whether wholly owing to the frost, or partly to the confinement and damp of the permanent inclosure, cannot now be ascertained.

John Parkinson, apothecary, of London, one of the most voluminous of our early writers on plants, who published his Practice of Plants in 1629, gives some curious directions for the pro-

servation of orange trees, from which one would be led to conclude that the trees at Beddington, with their ample protection of a movable covering in winter, had not been in existence then. "The orange tree," says he, "hath abiden, with some extraordinary branching and budding of it, when as neither citron nor lemon trees would by any means be preserved for any long time. Some keepe them in square boxes, and lift them to and fro by iron hooks on the sides, or cause them to be rowled on trundels or small wheels under them, to place them in an house, or close galerie, for the winter time: others plant them against a bricke wall in the ground, and defend by a shed of boardes, covered with seare cloth in the winter; and by the warmth of a stove, or such other thing, give them some comfort in the colder times; but no tent or meane provision will preserve them." The orange trees at Versailles are, during the winter, wheeled into warm places under the terrace; and the same plan is pursued with respect to some fine orange trees at Windsor, which were presented by the late king of France. At Hampton Court there are many orange trees, some of which are stated to be three hundred years old. They are generally moved into the open air about the middle of June, when the perfume of their blossoms is most delicious. Orange and lemon trees have been cultivated in the open air in England. For a hundred years, in a few gardens of the south of Devonshire, they have been seen, trained as peach trees against walls, and sheltered only with mats of straw during the winter. The fruit of these is stated to be as large and fine as any from Portugal.

At the time when the people of Europe first visited the Levant in great numbers, that is, during the crusades for the recovery of Syria from the dominion of the Saracens, oranges were found abundant in that country. Though they were in reality cultivated trees, their number, and the beauty and goodness of their fruit, naturally caused the adventurers (who were not very conversant with natural history, and not a little prone to romance and credulity) to believe and state that these were indigenous to the country, and formed a portion of the glories of the "Holy Land."

The fables of the profane writers, and the ambiguity of the descriptions of vegetables in Holy Writ, helped further to confirm this opinion. As the oranges were of the form of apples, and the colour of gold, it did not require much stretch of imagination to make them the golden apples of the garden of the Hesperides; and the only point that remained was to settle the locality of that fabled paradise, which was generally laid in the part of Africa which lies between the mountains of Atlas and the southern shore of the Mediterranean. The authority of Moses was called in to confirm the existence of this fruit in Syria, even at the time when the children of Jacob were wandering in the wilderness; and one of the trees borne in the procession commanded in the twenty-third chapter of the book of Leviticus, was considered to have been the orange. The *mala medica* of the Romans, which is mentioned by Virgil, and afterwards by Palladio and others; the *kitron* of the Greeks; and the *citrus* of Josephus, were all understood to mean the same fruit: and, as has been found to be the case with many other substances, the moderns supposed that, because there was an identity of name, there must be an identity of substance, never reflecting that the name had been imposed by themselves, and that therefore its identity proved nothing.

The fable continued, however; and, though there was a good deal of writing upon the subject, there was no attempt to examine the authorities with that minuteness which the search of truth demanded, till the nineteenth century. The history of this fruit was first carefully traced by Galessio, who published his *Traité du Citrus*, at Paris, in 1811. He maintains that the orange, instead of being found in the north of Africa, in Syria, or even in Media, whence the Romans must have obtained their "Median apples," was not in that part of India which is watered by the Indus at the time of Alexander the Great's Indian expedition, as it is not mentioned by Nearchus among the fruits and productions of that country. It is not mentioned either by Arrian, by Diodorus, or Pliny; and even so late as the year 1300, Pietro di Cuescengi, a senator of Bologna, who wrote on agriculture and vegetable productions, does not take the least notice of the orange.

The first distinct mention of oranges is by the Arabs; and Avicenna (book v.) not only describes *oleum de citrangula* (oil of oranges) and *oleum de citrangulorum seminibus* (oil of orange seeds,) but speaks of *citric acid* (salt of lemons,) which is contained in all the genus, though more abundantly in that species from which it got its common English name.

According to Galessio, the Arabs, when they penetrated to India, found the orange tribes there, further in the interior than Alexander had penetrated; and they brought them thence by two routes: the sweet ones, now called China oranges, through Persia to Syria, and thence to the shores of Italy and the south of France; and the bitter oranges, called in the commerce of England, Seville oranges, by Arabia, Egypt, and the north of Africa to Spain.

It does not appear that the orange was originally a Chinese fruit, as it is not mentioned by Marco Polo, the father of modern travellers, who is so circumstantial in describing all the other wonders of that country.

Now these facts certainly go far to show that

the orange was not known to the ancients either in Europe or in Syria; but that we are indebted for the first knowledge of it to the Arabs, who, with their zeal to propagate the religion of the Koran, were as anxious to extend the advantages of agriculture and medicine. The sweet orange which they introduced was not, strictly speaking, that which has since been called the China orange, and under that name introduced into Spain, Portugal, St Michael's, the other Atlantic isles, and the West Indies; but rather the orange which was known in Italy before Vasco de Gama had doubled the Cape of Good Hope.

The orange is said to have been found by the Portuguese upon the east coast of Africa; but it is not known whether it had been indigenous there, or disseminated by the Arabs. When the Portuguese reached India, they found the orange there, and also in China, which was visited for the first time by sea in the early part of the sixteenth century.

Although the oranges of St Michael, in the Azores, are now the best that are to be met with in the European market, they are not indigenous productions of that island; but were sent there by the Portuguese, as the same fruit was originally sent to the American continent by the Spaniards. In the middle of a forest, on the banks of the Rio Cedeno, Humboldt found wild orange trees, laden with large and sweet fruit. They were, probably, the remains of some old Indian plantations; for the orange cannot be reckoned amongst the spontaneous vegetable productions of the New World.

But, in whatever way oranges were first introduced into those parts of the world of which they are not natives, they are now very widely diffused; and wherever they are found they are among the most ornamental of trees, and the most delightful of fruits. The species and varieties have also been greatly multiplied; but whether from their proneness to produce varieties, from some original differences, or from difference of soil and climate, cannot now be ascertained. Including all the different species, Risso, an eminent naturalist at Nice, (and from his living in a country producing oranges, he had the best opportunities of examining and studying them,) has, in a very elegant and elaborate natural history of oranges, published at Paris in the year 1818, enumerated, described, and, with respect to all the more important sorts, figured no fewer than one hundred and sixty-nine varieties: these he has divided into eight species: sweet oranges, bitter oranges, bergamottes, limes, pampelucos, sweet limes, lemons, and citrons.

Of the first of these there are no fewer than forty-three varieties; though, in the opinion of Galessio, they are all derived from the common orange. The others are, generally speaking, more acid in their flavour; though some of them, such as the bergamottes, from the rind of which the celebrated oil of bergamot is obtained, are highly perfumed.

Of the bitter oranges Risso enumerates thirty-two varieties; of the bergamottes, five; of the limes, eight; of the pampelucos, six; of the sweet limes, twelve; of the lemons, forty-seven; and of the citrons, seventeen.

The family of the oranges, in almost all their varieties, are now cultivated in Portugal, in Spain, in France, in Italy, and in Greece. In the first two countries they especially abound; in Algarve, and in the fine plains of Andalusia, on the banks of the Guadalquivir. The latter is the place from which the bitter, or Seville, oranges are chiefly obtained. In Algarve and Andalusia the orange trees are of great size; and extensive orchards of oranges have formed the principal revenue of the monks for several centuries. In Cordova, the seat of Moorish grandeur and luxury, there are orange trees still remaining, which are considered to be six or seven hundred years old; and in that province, whose craggy mountains are covered with gardens, and vineyards, and forests abounding in fruit, the flowers of the orange fill the air with their perfume, and lead the imagination back to those days which the Moorish poets and historians delight in describing, when the land which they conquered was adorned with all the refinements of their taste and intelligence, and the luxuries of the East were naturalized in the most delicious regions of the South. The trunks of the old trees of Cordova have begun to decay; and when they get diseased, they are crusted with a kind of lichen, which is supposed to be peculiar to the orange. In France, the orange country is chiefly Provence, or that part of the south which lies to the eastward of the Rhone; and plantations or groves of oranges are the most abundant and the most beautiful on the banks of the Var, and especially in the environs of Nice, where the species are very many, and come to great perfection. To the west of the Rhone, the country along the coast is flat, sandy, and barren; and on the plains of Languedoc, that lie interior of this barren tract, the olive thrives better than the orange, apparently because there are no secondary mountains between the cold heights of the Cevennes and the plains. The country to the eastward of the Rhone is much better adapted for choice vegetables, both in soil and in aspect. In the western or French part of it, the Alps descend gradually, by successive elevations, from the high summits of Mont Blanc, Mont Rosa, and St Bernard, to the sea. Thus the low grounds are finely exposed to the southern sun; and being at the same time sheltered from every quarter whence a cold wind could come, the vegetation is at once luxuriant and choice. The finest bulbous flowers, the myrtle, the cactus, and many

others, give more the air of the perpetual summer of the tropical countries, than is to be found perhaps in any other country of Europe, certainly in any other of the same extent.

The glory of that delightful country is the orange, which, when full grown, attains the height of about five and twenty feet, and is graceful in all its parts. The trunk and older branches are of a delicate ash colour; the twigs of so soft a green that they almost appear transparent; the leaves are moderately large, beautifully shaped, of a fine healthy green, and shining on the upper sides, while the under ones have a slight appearance of down. The flowers, which are in little bunches, and very graceful in their form, are, in the sweet oranges, of a delicate white, and, in the more acid varieties of the family, lightly marked with pink. Some plants have a more powerful odour, and are for the moment more rich; but there is a freshness in the aroma of an orange-grove which never offends or cloys; and as the tree is at one and the same time in all stages of its bearing—in flower, in fruit just set, and in golden fruit, inviting the hand to pull and the palate to taste—it is hardly possible to imagine any object more delightful. The perfumes of Arabia do not exceed the fragrance of the groves on the north of the Mediterranean, in which the beautiful white Provence rose, the tuberose, and countless other flowers, blend their sweets with that of the orange; and where, with all this richness, the pestilent airs of the tropics, and even the *sirocco* of the southern parts of Italy, are altogether unknown. This delightful fertility and fragrance accompany the chain of the Apennines round the whole gulf of Genoa, and until, upon the boundary of the plain of Tuscany, they subside in elevation, and bend more toward the Adriatic.

Tuscany is further to the south; but the climate and the vegetation cannot be compared to those of the little valleys of Provence and Liguria, especially the latter. About Florence there are still orange trees in the gardens; but there are none of those aromatic groves and plantations which are found further to the west. Nor are the causes difficult to find out. There is an enemy on each side of the plain of Tuscany, which will not allow the orange to arrive at perfection. The gales that come from the south-east, over the sandy shores near Leghorn, are not adapted for a plant which, as well as heat and pure air, requires a considerable quantity of moisture; and the winds from the north, that are cooled in passing over the Adriatic, are not so genial as those from the Alps, that are warmed in passing over the vale of Lombardy. But still the olives, the grapes, and the melons, of the vale of the Arno, in so far compensate the inhabitants for the want of the orange.

Eastward of Tuscany, though the coast of Italy inclines still further to the south, it is even less adapted for the production of the orange; the sea coast is barren, the interior is dreary, and over the whole the pestilent *malaria* creeps, forbidding man to approach even for the cultivation of the fields; and thus it may be that, ere long, the arid downs by the sea will meet the marsh of the interior, and the centre of Italy shall be desolation to the very base of the Apennines. After the gulf of Gaeta is passed, and the shelter of the more elevated mountains of Calabria is obtained, orange groves again make their appearance.

Thus the locality of the orange depends fully as much upon situation and soil as upon latitude; and therefore we need not wonder that, considering the many and varied lands in which it is cultivated, there should be so many varieties of its fruit. There is no absolute reason for supposing that the sweet and the bitter orange were originally different; and even now they are not so different as two mushrooms of the very same variety—the one produced upon a dry and airy down, and the other upon a marsh. Now, if it be true that the bitter orange of Seville came, by successive removals, from the head of the Persian Gulf, along the margin of the salt desert, till it reached the states of Barbary, where it was transplanted into Spain; if the sweet orange of Malta, Italy, and France, came through the more fertile parts of Persia and Syria; and if the orange of India and the Azores came direct from China—it would follow that each should have those qualities which we find in it; and that the opinion of Galessio is borne out by the only evidence which the case admits.

Looking at the facts, we are induced to infer, that, if the temperature be sufficiently high for maturing its flavour, the orange is delicious in proportion to the uniform salubrity of the air; and that those high temperatures which force a very large expansion of the fruit are against the fineness of its quality. In this respect we have an opportunity of contrasting both the oranges of islands and those of continents. St Michael's, in the Azores, and Malta, are both small islands; the former always exposed to the equalizing breezes, which, from whatever quarter they blow, are always wafted across the expanse of the Atlantic; and the latter lying near the dry and sultry shores of Africa, and, of course, subjected to more changes of season and a higher temperature. There is also some difference in the soil. Whether it be the decomposition of the rock, or saline particles, brought by the same pestilent wind that withers the south of Italy and Sicily with the *sirocco*, it is well known that, under the artificial earth (brought originally from Sicily) which forms the soil of Malta, there gathers a crust; and that if the earth be not trenched, and this crust removed at the end of a certain

number of years, it ceases to be productive, or the produce becomes so bitter, that it is not healthful. St Michael's has no such disadvantage; the soil there is native and fertile, and deposits nothing calculated to injure its fertility, or impair the qualities of its produce.

The oranges of the two islands are such as one would expect from those differences. The Maltese orange is large, the rind is thick and spongy, the glands that secrete the volatile oil are prominent, the pulp is red, and there is a trace of bitterness in the taste; while the St Michael's orange is small, the rind is thin and smooth, the glands less prominent, the volatile oil in smaller quantity, and the lighter coloured pulp more sugary and delicious. Some allowance must no doubt be made for the original differences of those oranges, regarding them as having come in the manner stated by Galessio; but they have now been long enough in both islands for having their qualities modified by the different climates and soils.

The modifications produced by differences of soil and climate, in the same vegetable, are among the most important inquiries in the science of plants; and they are, at the same time, among the most difficult, and certainly the least attended to. One principal source of the difficulty lies in the observer being as much changed as the thing observed. Those who are parched with thirst do not stop to analyze the water, or descant upon the flavour of whatever beverage they may have recourse to for slaking it. The removal of the painful sensation is to them far more delicious than the purity of the most limpid spring, or the flavour of the choicest wine. Just so with man when he is panting under a burning atmosphere; the fruit which is most delicious to him is that which is most cool. This necessary change in the judge, as well as the thing judged of, must never be omitted when we come to compare the fruits of different countries as reported of by those who have enjoyed them there; and we never can be certain of their real merits till we have them decided by the same individual under the same circumstances. To take a case in point: a guava, apart from its rarity, is certainly not in this country any thing comparable to a peach; and yet those who have been in tropical countries talk in raptures of the guava, and say that the fruit grown here is inferior and degenerated. But they should bear in mind that, in the tropical countries, there is the tropical zest, as well as the tropical flavour. The man who traverses a mountain country in the north, heeds not the glittering fountains that issue from every rock around him; but send him from Suez to Bassora, or from Morocco to Fezzan, and he would remember them with veneration.*

* Library of Entertaining Knowledge.

But, again, we have a further confirmation when we compare the continental oranges. The climate of the slopes and valleys of the Estrella, near the lower Tagus, and that of the Maritime Alps, and the Apennines, in Provence and Liguria, are certainly very different from the climate of Andalusia. The diversities of surface, and the vicinity of the sea, keep the air over the former places in continual play and motion, and prevent those intense heats which unquestionably (though by a process which chemistry has not yet fully investigated) render the juices of plants acid, acrid, or saline; while, from the wider extent of Andalusia, and its comparative distance from the ocean, the air over it is, in the warmer months, much more quiescent.

These considerations will, to a certain extent, explain why there are so many varieties in a fruit, which, according to the authorities, appear all to have come from the same part of the world; and a further extension of these considerations would form a criterion of the situations in which it would, or it would not, be desirable to cultivate the orange.

One great recommendation of the orange is, that it may be had fresh in every region of the world, and almost at every season of the year. The tough rind, and the aromatic oil with which it is filled, protect it from both extremes of temperature; and the acidity of the pulp deters insects from piercing it; and if pulled from the tree before it is quite ripe, this fruit will keep for a long time. Indeed, the greater portion of the oranges imported into this country are taken from the tree while they are still green. This gathering of both oranges and lemons for the English market begins in October, and continues to the end of December. Oranges are not fully ripe till spring. It is found that the orange trees, from which the fruit is gathered green, bear plentifully every year; while those upon which the fruit is suffered to ripen, afford abundant crops only on alternate years.

During the latter end of the seventeenth and beginning of the eighteenth centuries, the orange tree was a very fashionable article of growth in conservatories, when there were but few exotics of other sorts kept there. The plants were procured from Genoa, with stems generally from four to six feet in height. They were planted in large boxes, and were set out during summer to decorate the walks near the house, in the manner still practised at Versailles and the Tuilleries. About the middle of the eighteenth century, when a taste for botany and forcing exotic fruits became general, that for superb orange trees began to decline. Many of these large trees have decayed through neglect, and those which are now to be found in the greater number of green-houses are generally dwarf plants, bearing few fruit, and those of small size. In some

places, however, are still to be found large and flourishing trees. Those at Smorgomy in Glamorganshire are the largest in Britain. They are planted in the floor of an immense conservatory, and bear abundantly. It is said that the plants were procured from a wreck on the coast in that quarter, in the time of Henry VII.

At Woodhall, near Hamilton, trees of all the species of citrus are trained against the back wall of forcing houses, in the manner of peaches, and produce large crops of fruit. At Castle Semple, near Paisley, there is a citron tree which, in 1830, covered a wall twenty-five feet in length, and sixteen feet high, besides returning about six feet on each end of the house. In that year it produced between seven and eight dozen of fruit, one of which measured eighteen inches and a half by nineteen and a half.*

THE LEMON *(citrus limonum)*. This is a knotty wooded tree, about eight feet in height,

128.

The Lemon.

with rough bark, and pale green leaves. The fruit is oblong and smooth, and rather thin skinned. The juice of the pulp is much more acid than that of the orange, and consists of the citric acid. The flavour of the essential oil of the rind is also peculiar and extremely grateful. Dr Sickler enumerates twenty-eight varieties as grown in Italy; the French cultivate eleven; and in the London nurseries are about twelve varieties.

The lemon grows naturally in that part of India which is situated beyond the Ganges; but its transmigration to Europe is due to the Caliphs during their invasion of the West. The lemon thus transplanted was found by the crusaders, in Syria and Palestine, towards the end of the eleventh century. By them it was introduced into Sicily and Italy, though it is probable that at the same period it was already multiplied in Africa and Spain. Arabian writers of the twelfth century speak of the lemon tree as then cultivated in Egypt and many other places. Matthew Silvaticus, a writer of that time, says, that the lemon was then spread over all Italy.

In the southern parts of Europe, where the lemon is abundant, the varieties are very numerous. Lemons are imported into this country both for their agreeable acid juice and essential oil, and also for the manufacture of citric acid in a concrete state. They will keep good for a considerable time, especially if steeped for a short period in salt water.

THE CITRON *(citrus medica)*. This is by some supposed to be the same species as the lemon. In its wild state the tree grows to the height of about eight feet, erect and prickly, with long reclining branches. The leaves are ovate, oblong, alternate, sub-serrate, pale green. The fruit is six inches in length, ovate, with a protuberance at the tip. There are two rinds, the outer thin, with innumerable miliary glands, full of a most fragrant oil; the inner thick, white, and fungous. The citron was introduced into Europe from Media, under the name of *malus medica*, and was first cultivated in Italy by Palladius, in the second century. The date of its introduction into England is not exactly known, it would probably be coeval with that of the lemon, which was cultivated in the botanic garden of Oxford in 1648. The fairest fruit, Millar states, was in the duke of Argyle's garden at Whitton, where the trees were trained against a south wall, through which there were flues for warming the air in winter, and glass covers put over them when the weather began to be cold; and thus fruit as large and as perfectly ripened was produced as any in Italy or Spain. In Italy, citrons and lemons are generally trained on walls or espaliers, because being considerably more tender than the orange, they require, at least in the north of Italy, some protection in winter. The fruit does not ripen regularly at one time, like that of the orange, but comes successively to maturity almost every month in the year. There are about six varieties cultivated in Britain: the common, the flat-fruited, the rough-fruited, the forbidden-fruited, the round-fruited, and the thick-leaved.

129.

The Citron.

THE LIME *(citrus acida)*. The sour lemon, or lime, grows to the height of about eight feet, with a crooked trunk, and many diffused branches armed with prickles. The leaves are ovate, lanceolate, almost quite entire. The fruit is an inch and a half in diameter, almost globu-

* London.

lar, with a protuberance at the top; the surface is regular, shining, greenish yellow, with a very

130.

The Lime.

odorous rind, enclosing an acid juice. It is a native of Asia, but has long been common in the West Indies, where it is raised both for its fruit and for fences. The juice of the lime is by some preferred to that of the lemon, and it is used for similar purposes. The following varieties are grown in the London nurseries: the common, the weeping, the broad-leaved, the West Indian, the Chinese spreading.

The Shaddock *(citrus decumana)* is much larger than the orange, both in the tree and the fruit. The tree is both lofty and spreading, and the fruit is about eight inches in circumference, some indeed, much larger. The shaddock is a native of China and the adjoining countries, where the name of "sweet ball" is given to it. There are many varieties, some with the pulp white, others with it nearly red; some that are sweet, with but little acidity; and some acid, with but little sweetness. The shaddock derived its specific name from having been first carried from China to the West Indies by Captain Shaddock. It has, however, been neglected there, and now but seldom merits its oriental name of sweet ball. The planters have never been remarkable for their knowledge of science, or their skill in the new operations of the arts; and thus, instead of propagating the shaddock by budding, as is done in China, and which is the only way that it can be improved, or even kept from degenerating, they have reared it from seed, and consequently have generally obtained a harsh and sour sort, which is of very little value. It is showy, no doubt, from its size, and the appearance of the tree when growing; but it is the least valuable or desirable of the genus produced in the west.

All the citrus tribe may be propagated by seeds, cuttings, layers, grafting, and budding. In general, citrons, lemons, limes, and shaddocks, are more easily propagated than the orange. The latter do not grow readily from cuttings, and it is advisable to raise them by engrafting. Raising from seed is a tedious process, as the plant is not fruitful for five or six years, even in Italy. They require a rich soil; and when in pots or in tubs, should be liberally supplied with water.

The Pomegranate *(Punica granatum)*. This plant, so celebrated in ancient and scripture history, belongs to the natural order *Myrtaceæ;* and to the class and order *icosandria monogynia* of

131.

The Pomegranate.

Linnæus. This fruit was called by the ancients the Carthaginian apple, because, according to Pliny, the tree was first known to grow in the vicinity of Carthage. There are two species: the *dwarf*, which bears very small fruit and flowers, and is common in the West Indies; and the common, or *grained*, from the number of seeds or grains contained within the pulp of the fruit. The pomegranate is rather a low tree, of about fifteen to twenty feet in height, with numerous slender branches, some of which are armed with sharp thorns. The leaves are opposite, about three inches long, and of a beautiful green. The flowers are produced at the end of the branches, on the shoots of the same year, single, or three or four together; frequently one of the largest terminates the branch; and immediately under that are two or three smaller buds, which continue a succession of flowers for some months, generally from June to September. The calyx is very thick and fleshy, and of a fine red colour; the petals are scarlet. The beauty of the tree, independently of its fruit, has caused it to be planted for ornament in the south of Europe, and in many countries in the East. "The nightingale," says Russel in his account of Aleppo, "sings from the pomegranate groves in the day-time." The fruit is a berry, covered with a hard leathery coat, and beautifully crowned with the tube of the calyx, which is sharply toothed, and remains even after the fruit is ripe, contributing greatly to its singular and beautiful appearance. The fruit ripens in October; and in a green-house will hang on the trees till the spring or summer following. It was introduced into England in 1596, and cultivated by Gerarde; but though it grows very well in the open air, and is prized for the beauty of its flowers, especially the double variety, yet it seldom ripens its fruit. Even at

Paris it will not bear exposure in the open air in early spring. Some of the pomegranate and orange trees at Versailles, Risso states to be between two and three hundred years old.

Before the peach, the nectarine, and the apricot, had travelled from Persia to the more western countries on the borders of the Red sea, the pomegranate was there assiduously cultivated, and held in the greatest esteem. In the wilderness, when the children of Israel murmured for the fruits of Egypt, they exclaimed, "It is no place of seed, or of figs, or of vines, or of pomegranates." On the borders of the promised land, Moses described it as "a land of wheat, and barley, and vines, and fig trees, and pomegranates; a land of oil-olive and honey." In the Canticles, Solomon speaks of "an orchard of pomegranates, with pleasant fruits." A tree, therefore, which partakes of the antiquity of the vine, the fig, and the olive, and which, in point of utility, is numbered with the grain-bearing plants, and with honey, all constituting the principal food of the nations of antiquity in their early stages of civilization, must possess a considerable historical interest. It is probable that the pomegranate, differing from the stone fruits, travelled from the West to the East. Pliny says that it is a native of Carthage, as its name *(punica granatum)* imports. Yet as it is found wild in the same botanical regions of Europe, that is, in countries having the same temperature as the northern coasts of Africa, it is probably indigenous there also. It is still common in Barbary (where, according to Shaw, the fruit often weighs a pound, and is three or four inches in diameter), in the south of France, in Italy, in Spain, and throughout the East. The Jews employ the fruit in their religious ceremonials; and it has entered into the heathen mythology—for in the isle of Eubœa there was formerly a statue of Juno, holding in one hand a sceptre, and in the other a pomegranate.

The single flowering sorts may be raised from seed, and all the varieties by cuttings, suckers, or layers, or by inoculation or grafting on the wild sort. The tree thrives best in a strong rich soil.

The pomegranate is common in Syria and Palestine, particularly in all the gardens of Aleppo. The ripe fruit is in abundance in August, and is then laid up for a winter stock. There are three sorts, a sour kind, a moderately sweet kind, and a very sweet kind. The juice of the first is used instead of verjuice, or the juice of the unripe grapes; the others are eaten at table, after being cut open, the seeds taken out, strewed with sugar, sprinkled with rose water, and served up on little plates. The pomegranates, on account of their round and graceful figure, formed a frequent ornament on the chapiters of the building of the temple. "And the chapiters upon the two pillars had pomegranates also above, over against the net-work; and the pomegranates were two hundred, in rows round about." They were also embroidered upon the hem of the high-priest's ephod. A wine is sometimes extracted from these fruits, and probably was so by the ancient Jews, as may be inferred from the word "Gath Rimmon," signifying the press of pomegranates. The seeds, according to Russel, constitute an important culinary article in the manufacture of conserves and syrups. We must not judge of the pomegranate from the stunted specimens to be found in this country. In warm climates it grows to a considerable size; and several towns and places have derived the name of *Rimmon* from the abundance or excellence of this tree. The bark has been used in dyeing; and it is this which gives the colour to yellow Morocco leather.

THE FIG, *(ficus carica)*. Natural order *Urticaceæ*. *Polygamia diœcia* of Linnæus.

132.

The Fig.

The fig is a native of Asia, Africa, and the south of Europe, and has been cultivated from remote antiquity in the countries surrounding the Mediterranean, where it forms a principal article of food in many places. The stem is from fifteen to twenty-five feet high, with a trunk sometimes two feet in diameter, giving out a great number of long, twisted, pliant branches, which are grayish and rough when young; the leaves are deciduous, of the size of the hand, having three to five rounded lobes; the flowers are very small, unisexual, contained in great numbers in a common receptacle, which is fleshy and connivent at the summit, where it is almost closed by a series of little teeth; the male flowers occupy the superior part of this receptacle, and the female, which are the most numerous, the bottom, and all the remaining part of the cavity; each ovary becomes a seed, surrounded with a pulp, which, together with the receptacle, forms the fruit. The fruit is solitary, generally of a purplish colour, has a soft, sweet, fragrant pulp, and is much esteemed, being constantly brought upon the table, during five months of the year, in the south of Europe. The greater part of the flowers prove abortive, both with and without the process of caprification.

This process is performed by suspending by threads, above the cultivated figs, branches of the wild fig, which are full of a species of cynips. When the insect has become winged, it quits the wild figs and penetrates the cultivated ones, for the purpose of laying its eggs; and thus it appears both to ensure the fructification by dispersing the pollen, and afterwards to hasten the ripening by puncturing the pulp, and causing a dispersion or circulation of the nutritious juices. In France, this operation is imitated by inserting straws dipped in olive oil. Many of the French naturalists are of opinion, that caprification is a very unnecessary process. Oliver terms it a "tribute which man pays to ignorance and prejudice." In many countries of the Levant, he says, it is not now performed, nor is it done in France, Italy, or Spain. Perhaps it may tend to hasten in some degree the maturation of the fruit; but it does not seem to be essential to fecundation; nor, indeed, is fecundation itself indispensably requisite to the swelling and ripening of the fig.

The traditions of the Greeks carried the origin of the fig back to the remotest antiquity. It was probably known to the people of the East before the *cerealia;* and stood in the same relation to men living in the primitive condition of society, as the banana does to the Indian tribes of South America, at the present day. With little trouble of cultivation, it supplied their principal necessities; and offered, not an article of occasional luxury, but of constant food, whether in a fresh or a dried state. As we proceed to a more advanced period of the history of the species, we still find the fig an object of general attention. The want of blossom on the fig-tree was considered as one of the most grievous calamities by the Jews. Cakes of figs were included in the presents of provisions by which the widow of Nabal appeased the wrath of David. In Greece, when Lycurgus decreed that the Spartan men should dine in a common hall, flour, wine, cheese, and figs were the principal contributions of each individual to the general stock. The Athenians considered figs an article of such necessity that their exportation from Attica was prohibited. Either the temptation to evade this law must have been great, or it must have been disliked; for the name which distinguished those who informed against the violators of the law, compounded from συκον, a fig, and φαινω, to shew, became a name of reproach, from which we obtain our word sycophant. As used by our older writers, sycophant means a *tale-bearer;* and the French employ the word to designate a liar and impostor generally, not a flatterer merely. At Rome the fig was carried next to the vine, in the processions in honour of Bacchus, as the patron of plenty and joy; and Bacchus was supposed to have derived his corpulency and vigour, not from the vine, but from the fig. All these circumstances indicate that the fig contributed very largely to the support of man; and we may reasonably account for this from the facility with which it is cultivated in climates of moderate temperature. Like the cerealia, it appears to flourish in a very considerable range of latitude; and even in our own country frequently produces fine fruit, without much difficulty, in the open air. Yet the tree is not generally cultivated except in very favourable situations; and it must belong to more genial climates to realize the ancient description of peace and security, which assigns the possession of these best blessings of heaven to "every man under his own fig tree."

The double, and, in some climates, the treble, crop of the fig tree, is one of the most curious circumstances belonging to its natural history, and further illustrates the value attached to it in the countries of the East. It offers the people fruit through a considerable portion of the year. The first ripe figs, according to Dr Shaw, are called boccôre, and come to maturity about the latter end of June; though, like other trees, they yield a few ripe before the full season. These few are probably of inferior value; for the prophet Hosea says, "I found Israel like grapes in the wilderness; I saw your fathers as the first-ripe in the fig tree at her first time." When the boccôre draws near to perfection, the karmouse, or summer fig, begins to be formed. This is the crop which is dried. When the karmouse ripens in Syria and Barbary there appears a third crop, which often hangs and ripens upon the tree after the leaves are shed.

The time of gathering the summer fig in the Levant, with its corresponding process of drying and packing for the European market, is one of considerable bustle and activity. The principal seat of this commerce is Smyrna.

The import of figs to Great Britain alone, which is principally from Turkey, amounts to nine hundred tons annually, subject to a duty of £1 1s. per cwt. Dry figs form, also, a very considerable article of commerce in Provence, Italy, and Spain; besides affording, as in the East, a chief article of sustenance to the native population. In Spain the principal exports of dried figs are from the provinces of Andalusia and Valencia; though the fruit grows, more or less, in every province. In the northern parts of France there are many fig gardens, particularly at Argenteuil.

It is probable that if the fresh fig were much esteemed by the people of this country, the tree would be more extensively cultivated here in favourable situations, such as our southern coast.

But it would seem, from our old writers, and indeed from a common expression even of the present day, that, from some association of ideas,

the fig was an object of contempt. "*Figo* for thy friendship," says Pistol. Stevens, the commentator on Shakspear, thinks that the "fig of Spain," mentioned in many of our old poets, alluded "to the custom of giving poisoned figs to those who were the objects of Spanish or Italian revenge;" and hence, probably, a vulgar prejudice against the fruit. We have, however, old trees still remaining in some gardens, which bear good crops. These are generally trained against walls; but fig trees have also been planted as standards here with success. We shall mention a few instances of each case.

The fig tree is said to have been first brought into England, in 1525, by Cardinal Pole; though probably it was introduced before, both by the Romans and the monks. The specimens came from Italy, and are still in the archbishop's gardens at Lambeth. They are of the white Marseilles kind, and bear excellent fruit. In the course of their long existence, they have attained a size far exceeding the standard fig tree in its native situations. They cover a space of fifty feet in height, and forty in breadth. The trunk of the one is twenty-eight, and the other twenty-one inches in circumference. In the severe winter of 1813-14, those venerable trees were greatly injured; and, in consequence of the injury, it was found necessary to cut the principal stems down nearly to the ground; but the vegetative powers of the roots remained unimpaired, and they are shooting up with great vigour.

In the garden of the manor-house at Mitcham, which was formerly the private estate of archbishop Cranmer, there was another fig tree of the same sort, which is generally understood to have been planted by that prelate. It was low, compared with the trees at Lambeth, but had a thicker stem. It was destroyed some time before the close of the last century.

Another celebrated fig tree was in the Dean's garden at Winchester. It bore a small red fig, and was in a healthy state in the year 1757. It was inclosed in a wooden frame, which had a glass door, with two windows on each side, by which the sun and air were admitted, while the frame protected it from the wind and rain. On the stone wall to which the tree was nailed, there were several inscriptions; and, among the rest, one which mentioned that, in the year 1623, King James I. "tasted the fruit of this tree with great pleasure." That tree also has been destroyed.

A few years since, there was a fine old fig tree at the back of a house, in King street, Covent Garden. The trunk has now been cut down to build a wall where it grew; but shoots are springing up from the root. This tree was doubtless one of the *Convent garden;* which, in the reign of Elizabeth, bounded the Strand, on the north, extending from St Martin's lane to Drury lane, these two lanes being the only approaches to the neighbouring village of St Giles.

The *pocock fig tree* is one of the most celebrated in this country, and was once supposed to have been the first of the white Marseilles figs introduced into England. The tradition is, that it was brought from Aleppo by Dr Pocock, the celebrated traveller, and planted in the garden of the Regius professor of Hebrew at Christ Church, Oxford, in the year 1648. An extract from a communication by Mr William Baxter, curator of the Botanical Garden at Oxford, read before the Horticultural Society in 1819, contains the latest history of this tree. It received considerable damage from the fire that happened at Christ Church on the 3rd of March, 1809: till that time, the large trunk mentioned by Dr John Sibthorpe, in Martyn's edition of Miller's Gardener's Dictionary, remained. In order to preserve it from the injuries of the weather, this trunk had been covered with lead; but at the time of the fire the lead was stolen, and, soon after, the trunk itself decayed, and was removed. The tree in 1819 was in a very flourishing state. There are some remains of the old trunk to be seen a few inches above the surface of the ground. The branches then growing were not more than eight or ten years old; but those in the middle of the tree were twenty-one feet high.

It is probable that standard fig trees were formerly much more common in this country than at present. Bradley, an old writer on agriculture, mentions an ancient fig tree at Windsor, which grew in a gravel pit, and bore many bushels every year, without any pains being bestowed upon it.

In the fourth volume of the Horticultural Transactions, there is a very interesting account, by Mr Sabine, of some standard fig trees in the garden of a cottage at Compton, near Worthing, in Sussex. The garden in which they stand slopes gently to the south, is protected on the north by a thick grove of apple and plum trees, and the climate is very mild. "The number of the fig trees," says Mr Sabine, "is fourteen; they occupy the principal part of the garden, which is very small, and are in perfect health; their average height is about ten feet; and, if any of the larger ones were detached, they would cover a space of twelve feet in diameter. Their stems are not large: the plants are bushes rather than trees, for the branches spread in all directions from the root. These are propped up by stakes, but many of them are suffered to hang near the ground." Mr Kennard, to whom they belonged, informed Mr Sabine, that though the quality varied, there always was a crop; that the figs began to ripen in the end of August, or beginning of September, and continued during October; that the crop was generally from the spring figs, though occasionally a few of the autumn

ones ripened; that he manured the ground every autumn; and that he pruned as little as possible.

In the neighbourhood of Worthing, and indeed along nearly all the south-east coast of Sussex, fig trees are very common in the gardens. At Tarring (about two miles from Worthing) there is a remarkable plantation of figs, called by the inhabitants of that village, the "fig garden." The trees, which are about eighty in number, grow luxuriantly at intervals of about twelve feet, on the sides of the paths. They are about fifteen feet high; and the stems are from six to eleven inches in diameter. The people to whom the garden belongs know nothing of the history of these trees; but it is believed that they were planted about fifty years ago.

With the requisite degree of care, figs may be readily obtained in this country in a hot-house; but they require a mode of cultivation so peculiar, that if it is wished to procure them in perfection they ought to be cultivated along with no other fruit, and then two or three crops may be gathered.

Figs may be propagated in all the modes usual with other fruit trees. The most approved method is by layers or cuttings, which come into bearing the second, and even the first year.

The fig tree, as already stated, is distinguished from almost all others by the extraordinary property of producing two crops of fruit in the same year on distinct shoots, in climates congenial to its growth. The shoots formed by the first or spring sap, put forth figs at every eye, as soon as the sap begins to flow again in July and August. These figs, which form the second crop of the year, ripen in their native climate during the course of the autumn; but rarely if ever come to perfection in England, where, though they cover the branches in great abundance at the end of that season, they perish and fall off with the first severe frosts of winter. The shoots formed by the second flow of sap commonly called midsummer shoots, put forth figs in like manner at every eye, but not until the first flow of sap in the following spring. These last mentioned figs, which form the first crop of each year, ripen in warmer climates during the month of June and July, but not in this country before September or October. In warmer climates indeed very little attention is given to this first crop, because the midsummer shoots on which it is borne are commonly in proportion only of one to six or eight in length, when compared with the shoots of the spring, which produce the second crop, and the crop itself is always small in the same proportion; but in England it is the reverse, as no care or skill of the gardener can ever insure a second crop of ripe figs in the open air.

THE OLIVE *(olea Europæa)*. Natural family *oleinæ; diandria, monogynia*, Linnæus. The olive is a low branching evergreen tree, in height from twenty to thirty feet, with stiff narrow dark-green or bluish leaves. The flowers are

133.

The Olive.

produced in small axillary bunches, from wood of the former year, and appear in June, July, and August. The fruit is a berried drupe of an oblong spheroidal form, the fleshy part hard and thick, at first of a yellowish green colour, but becoming black when ripe. The tree is supposed to have been originally a native of Greece; but it is now naturalized in the south of France, Italy, and Spain, where it has been extensively cultivated for an unknown length of time, for the oil expressed from its fruit. The tree attains an incredible age. Near Ferni, in the vale of the cascade of Marmora, is a plantation, above two miles in extent, of very old trees, and supposed to be the same plants mentioned by Pliny as growing there in the first century of the Christian era.

The young olive bears fruit at two years old; in six years it begins to repay the expense of cultivation, even if the ground is not otherwise cropped. After that period, in good years, the produce is the surest source of wealth to the farmer. A common saying in Italy is, "if you want to leave a lasting inheritance to your children's children, plant an olive." There is an old olive tree, says a recent traveller, near Gericomio, which last year (1819) yielded two hundred and forty English quarts of oil; yet its trunk is quite hollow, and its empty shell seems to have barely enough hold on the ground to secure it against the mountain storm.

There is something peculiarly mild and graceful in the appearance of the olive tree, even apart from its associations. The leaves bear some resemblance to those of the willow, only they are more soft and delicate. The flowers are as delicate as the leaves. At first they are of a pale

yellow; but when they expand their four petals, the insides of them are white, and only the centre of the flower yellow. The matured wood of the olive is hard and compact, though rather brittle, and has the pith nearly obliterated, as is the case with box. Its colour is reddish, and it takes a fine gloss; on which account the ancients carved it into statues of the gods; the moderns make it into snuff-boxes and other trinkets.

Besides its use for the production of oil, the unripe olive is used as a pickle. For this purpose they are steeped in an alkaline solution, to extract a part of their bitter; they are next washed in pure water, and afterwards preserved in salt and water, to which fennel, or some aromatic, is sometimes added.

The wild olive is found indigenous in Syria, Greece, and Africa, on the lower slopes of the Atlas. The cultivated one grows spontaneously in many parts of Syria, and is easily reared in all parts of the shores of the Levant that are not apt to be visited by frosty winds. Where olives abound they give much beauty to the landscape. "The beautiful plain of Athens, as seen toward the north-west from Mount Hymettus, appears entirely covered with olive trees." Tuscany, the south of France, and the plains of Spain, are the places of Europe in which the olive was first cultivated. The Tuscans were the first who exported olive oil largely, and thus it has obtained the name of Florence oil; but the purest is said to be obtained from about Aix in France.

The particular departments of France in which the olive is most successfully cultivated are those of the Mouths of the Rhone, of the Var, of the Gard, and some others; but it does not ripen its fruit to the north-west of a line drawn from the Pyrenees, near Narbonne, to the foot of the little St Bernard in the Alps; or in that part of France which may be considered as forming a portion of the basin of the Mediterranean, and which is enclosed between that sea and the mountains of Cevennes and the Alps.

The proper time for gathering olives for the press is the eve of maturity. If delayed too long, the next crop is prevented, and the tree is productive only in the alternate years. At Aix, where the olive harvest takes place early in November, it is annual: in Languedoc, Spain, and Italy, where it is delayed till December or January, it is in alternate years. The quality of the oil, also, depends upon the gathering of the fruit in the first stage of its maturity. It should be carefully plucked by the hand; and the whole harvest completed, if possible, in a day. To concoct the mucilage, and allow the water to evaporate, it is spread out, during two or three days, in beds three inches deep. The oil mill is simple. The fruit is reduced to a pulp, put into sacks of coarse linen, or feather-grass, and subjected to pressure. The oil first expressed is the purest. The oil of the kernel is said to injure that of the fruit, and cause it to become sooner rancid. The growth of olives and the manufacture of the oil offer a considerable employment to many of the inhabitants of France and Italy. The importation of olive oil into Great Britain amounted, in 1827, to about four thousand five hundred tons, paying a duty of eight guineas per ton.

The olive grows in England, though, in the severity of our winters, it changes its character. In the south it is an evergreen; but in England it loses its leaves. Indeed, it needs protection even in the mildest winters; and it is only in the very warmest summers that it will produce fruit a little, which does not ripen, and is of very slight flavour. It appears to have been cultivated in the botanic garden of Oxford in 1648. In Devonshire some trees have stood the open air for many years. Some trees, planted against a warm wall at Camden house, near Kensington, succeeded so as, in 1719, to produce fruit fit for pickling.

In ancient times, especially, the olive was a tree held in the greatest veneration, for then the oil was employed in pouring out libations to the gods; while the branches formed the wreaths of the victors at the Olympic Games. It was also used in lubricating the human body. Some of the traditions say that it was brought out of Egypt to Athens by Cecrops; while others affirm that Hercules introduced it to Greece on his return from his expeditions; that he planted it upon Mount Olympus, and set the first example of its use in the games. The Greeks had a pretty and instructive fable in their mythology on the origin of the olive. They said that Neptune, having a dispute with Minerva as to the name of the city of Athens, it was decided by the gods that the deity who gave the best present to mankind should have the privilege in dispute. Neptune struck the shore, out of which sprung a horse; but Minerva produced an olive tree. The goddess had the triumph; for it was adjudged that peace, of which the olive is the symbol, was infinitely better than war, to which the horse was considered as belonging, and typifying. Even in the sacred history, the olive is invested with more honour than any other tree. The patriarch Noah had sent out a dove from the ark, but she returned without any token of hope. Then "he stayed yet other seven days, and again he sent forth the dove out of the ark; and the dove came to him in the evening, and, lo, in her mouth was an olive branch plucked off: so Noah knew that the waters were abated from the earth."

The veneration for the olive, and also the great duration of the tree, appears from the history of one in the Acropolis at Athens. Dr Clarke has this passage in his Travels, in speak-

ing of the temple of Pandrosus: "Within this building, so late as the second century, was preserved the *olive tree* mentioned by Apollodorus, which was said to be as old as the foundation of the citadel. Stuart supposed it to have stood in the portico of the temple of Pandrosus (called by him the Pandroseum) from the circumstance of the air necessary for its support, which could here be admitted between the caryatides; but instances of trees, that have been preserved to a very great age, within the interior of an edifice inclosed by walls, may be adduced."

The province of Suse, in Morocco, produces great abundance of olive oil, which is stated to be equal in quality to the best Florence oil, when it is expressed from the fruit before it becomes quite ripe. Mr Jackson, in his Account of the Empire of Morocco, mentions a curious circumstance regarding an extensive plantation of olive trees in the neighbourhood of Messa, which indicates the great facility with which this tree may be propagated. Being struck with the whimsical arrangement of this large plantation, he inquired the cause of their being so arranged, which was thus explained: "I learnt from the viceroy's aide-de-camp, who attended me, that one of the kings of the dynasty of Saddia, being on his journey to Soudan, encamped here with his army; that the pegs with which the cavalry picketed their horses were cut from the olive trees in the neighbourhood; and that these pegs being left in the ground, on account of some sudden cause of the departure of the army, the olive trees in question sprung up from them. I confess, while I acknowledge the ingenuity of the idea (for the disposition of the trees exactly resembled the arrangement of cavalry in an encampment), I treated it as fabulous. Some time afterwards, however, the following circumstance occurred, which induced me to think the story was not only plausible, but very credible. Having occasion to send for some plants for a garden which I had at Agadeer, or Santa Cruz, the foulah (gardener) brought, amongst other things, a few bits of wood, without any roots or leaf, about eighteen inches long, and three in circumference, which he with a large stone knocked into the ground. Seeing the fellow thus employed, I asked him what he meant by trifling in that way? 'I am not trifling,' said he, 'but planting your pomegranate trees.' I began to take them out of the ground; but some persons who were near assuring me that it was the mode in which they were always planted, and that they would (with the blessing of God) take root and shoot forth leaves the next year, I was at length prevailed on to leave a few in the ground, merely for experiment; and they certainly did take root, and were in a fair way of becoming good trees when I left Santa Cruz."

The olive will grow luxuriantly in a strong clayey richly manured soil; but will not be so prolific as in a dry, calcareous, schistous, sandy, or rocky situation, which ought to be imitated in some degree in the green house. The mode of propagation is generally from suckers, which arise abundantly from the roots of the old trees. In pruning, the object is to have a regular distribution of wood of the former year from the axils of the leaves, of which the flowers spring out. When shoots of three or more years are shortened for this purpose, they do not produce blossoms; but wood of the preceding or current year may be shortened, and the shoots proceeding from them will produce blossoms in due course.

In the olive countries the varieties are nearly as numerous as those of the grape or fig. The French describe between thirty and forty sorts. The following are found in the English nurseries:—

The Common.
Large leaved.
Broad leaved.
Iron coloured.
Twisted leaved.
Box leaved.

Besides the extensive consumpt of olive oil in the countries where it is produced, there is an annual exportation to a great amount. In 1831, four millions, one hundred and fifty-eight thousand gallons, were imported into Great Britain, nearly one-half of which was retained for home consumption.

The following interesting details of the olive trade were communicated to the Library of Entertaining Knowledge by a gentleman long resident on the spot.

"All that part of Italy which may be called the heel of the boot, is little else than one continuous olive grove. It forms an extreme point of the Neapolitan kingdom, and is divided into two provinces, viz. Bari and Lecce, or La Terra d'Otranto. Its principal ports are Bari, Brindisi (the ancient Brundusium), Otranto, Gallipoli (now the most important of them all), and Taranto (the ancient Tarentum). Starting from Gallipoli, as I have often done, and travelling to the Cape Santa Maria di Leuca, or to Taranto, or to Lecce, a very large city, and the capital of one of the provinces, you literally are scarcely ever ten minutes out of the shade of olive trees. The slight cultivation of grain, &c., which is not nearly enough for the consumption of that district, is carried on in the midst of olive groves. Before and behind you, on hill or in hollow, you see scarcely any thing but *oliveti*. I have stood on the terrace of an old baronial castle at the town of Parabita, and seen the olive grove spread around me on every side for many miles, like a dull sea of leaves. Though so much poetry is associated with this emblem of peace, the tree itself is certainly neither picturesque nor poetic;

and travelling through them for such a length of time, with scarcely any other object to relieve the eye, is excessively monotonous and tedious. Starting again from the city of Lecce to Otranto, or to Brindisi, you have olive groves nearly the whole of the way; or going on from Lecce to Bari, with short interruptions at the mountains of Ostuni and one or two other places, your road lies through the same continuous plantation of olives. The soil of these districts is very stony, and waved into hills of slight elevation. It is in no part remote from the sea, whose contiguity is certainly favourable to the growth of this valuable tree. Though the long summer heats, and the sirocco blowing from Africa, are most oppressive at morning, mid-day, and evening, the narrow neck of land is generally refreshed by breezes from the open Mediterranean, or the Adriatic, or the Gulf of Taranto. These immense olive groves bear every year; but it is a well known fact here, as in the south of Spain, Greece, and all the other oil countries I have visited, that they never produce the same, or any thing like the same, quantity of fruit two years following. They have what the people there call a '*si e no*,' or a '*buon'annata*' and a '*cattiva annata*,' or a good year and a bad one, and this, in ordinary cases, in regular alternation; the groves bearing a bad crop this year, bearing a good one the next, and those highly productive this year being proportionably less productive the next year.

"I could not ascertain the precise time at which they cease to bear; but I have seen abundance of fine fruit taken from trees whose trunks were sadly hollowed, and seemed altogether sapless, and which were known to have been planted a century and a half before the time of my observation. I believe, however, that after a hundred years the tree requires manure and more attention, and gradually decreases in its power of production. As the whole wealth of the country consists in olives and oil, and as all hands are employed or interested in this branch of agriculture, it is amusingly curious to observe what frequent allusions are made to it in the popular parlance. A man who is in a gay humour is said to be 'as merry as if he had *la buon'annata*,' or the good year of olives, and so on with the reverse, when a man is in a bad humour. An improvident person, who dies and leaves his family badly provided for, is said to have left '*un'eredità di oliveti antichi*' (a fortune of olive trees past bearing); or they say he has consumed all the *buone annate* (good years), and bequeathed the bad ones.

"The oil throughout these two provinces, where the soil and cultivation vary but very little, is much the same at its production; but its quality is very considerably influenced by the nature of the wells or cisterns where it may be preserved afterwards. It is carried to Trani, Barletta, Bari, Molo di Bari, Molfetta, Giovenazza, Brindisi, Otranto, Taranto, and some other sea-ports; but its great *depôt* for some ages has been the town of Gallipoli, which gives its name to the oil imported in such great quantities by the English, French, Americans, and other nations, though, in fact, that oil is not produced exclusively in the country of Gallipoli, but throughout the two provinces I have described.

"Gallipoli owes this very advantageous preference not merely to its port, which, though bad enough (as I have occasion to remember, having once been nearly driven from my anchorage upon some saw-like rocks), is infinitely better and more accessible than any of the others; but to the quality of the rock on which the town is built. This rock is a small island, which is united to the main land by a bridge, and entirely covered by the city, whose walls follow the shape of the low cliffs, and rise on all sides perpendicular from the sea.

"This solid compact base is easily excavated; and in caverns thus constructed oil clarifies sooner, and keeps without rancidity much longer, than in any other place. Hençe numerous oil-houses are established at Gallipoli, and a very considerable portion of the rock is cut into cisterns. A Gallipolitan oil-warehouse generally occupies the ground-floor of a dwelling house, and has a low arched roof. Some are more extensive; but on an average they are about thirty feet square. In the stone floor you see four, six, or more holes, which are circular, about two feet in diameter, and like the mouths of wells. Each of these holes gives access to a separate *cisterna* beneath your feet; and when the oil is poured into them, care is taken not to mix different qualities or oils at different stages in the same reservoir. One cistern is set apart for '*oglio mosto*,' or oil that is not clarified, another for pure oil of the season, another for old oil, &c. I have seen oil that had thus been preserved for seven years in a perfect state, or, as the Gallipoli merchants' documents have it, '*chiaro, giallo, e lampante*,' words which I can never forget, for during some months I must have heard them at least a hundred times a day. I also many times verified the fact, that the *mosto*, or oil, in its turbid state, which arrived almost as black and thick as pitch, soon became bright and yellow in these excellent reservoirs without any help from man.

"All the oil, whatever may be its quality, is brought to the magazine in sheep or goat skins, which are generally carried on mules, there being but few *strade rotabile*, or roads, fit for wheeled carriages in these parts. In a good year, and at the proper season, I have counted, in the course of an afternoon's ride, as many as a hundred

mules returning from Gallipoli, where they had been to deposit their unctuous burdens, to different towns and villages in the Terra d'Otranto, or the more distant province of Bari. The quantity of oil required may be conceived when I state, that at one time (in the year 1816) I saw nine English, three American, two French, and six Genoese vessels (not to mention some small craft from the Adriatic), all waiting in the port of Gallipoli for entire or partial cargoes of it. When the oil is to be shipped it is drawn off from the *cisterne* into *uteri*, or skins, and so carried on men's shoulders down to a small house on the sea shore. In that house there is a large open basin, capable of containing a given quantity, and of measuring the liquid, and into that the porters empty their skins as they arrive. A tube communicates from the basin to a large cock at the outside of the house. When the basin is full, well made casks of various sizes, for the convenience of stowage, are placed under the cock, which is then turned, and the casks are filled. As the casks are closed up by the cooper, the porters roll them down to the brink of the sea, where the sailors secure several of them together with a rope, and taking the end of the cord into the boat, they row off to the vessel, towing the oil casks through the water after them.

"Each porter being able to carry but a small quantity at a time, the number of men and boys employed to load a ship is very considerable; and as these are an active fine limbed set of fellows, going with their legs and arms entirely bare, and running up and down and crossing each other with their oil skins, on their way to and from the town, with great rapidity, and as they delight in singing as they work, and moreover, frequently sing very well in parts and concert, the scene presented on such occasions is often very animating and pleasing.

"The hilarity of the Gallipolitans when I first became acquainted with them, might have been heightened by an agreeable contrast, for it was shortly after the fall of Bonaparte, whose system, whatever good parts of it may have done in the rest of Italy, was certainly most ruinous to the provinces of Lecce and Bari. Unable to export or to find any market for their produce, the proprietors in many parts of those provinces let the olives lie and rot upon the ground. For some years, indeed, the price of oil scarcely paid the cost of its preparation, to say nothing of transport and other necessary expenses. During the continental system the best '*chiaro, giallo, e lampante*' oil was sold at Gallipoli for eight Neapolitan ducats the *salma;** in 1816 and 1817 it found a ready market at from sixty to seventy ducats per *salma!*

* The salma is equal to 42¾ English gallons.

"Those who, during the evil time, had penetration enough to foresee better days, and that a system opposed to the general commercial prosperity of Europe could not last, and who had at the same time money enough for such objects by annually making their oil as usual, and by buying up the oil of others at the low current prices of the day, realized enormous profits when peace threw open the port of Gallipoli, and ships of all nations flocked thither as before.

"I have been in no part of Europe where the benefits resulting from the peace were so broad and tangible as here. At the end of 1816 these provinces had already partially recovered; those proprietors whom the war had left in debt were gradually paying off their obligations; those groves which had been almost abandoned were again looked to as a source of wealth, and the poor peasantry were restored to their ancient employment. In 1818 the improvement was much farther advanced; and though, since that period, owing to the increased use of gas, the extended cultivation of rape for oil, and various other circumstances, the olive oil shipped at Gallipoli and other ports has declined considerably in price and somewhat in quantity, it may still be held as a valuable product; and Lecce and Bari, in regard to the condition of the rest of the kingdom they belong to, may be considered as two prosperous provinces.

"The olives of which the Gallipoli oil is made are never gathered, but allowed to drop in their maturity from the tree on the ground, where they are picked up chiefly by women and children, and carried to the mill.

"The machinery employed in expressing the oil is of the rudest kind, and no doubt numerous improvements might be introduced, not only into this branch, but into that of cultivating the olive tree. The peasantry, however, and in the kingdom of Naples those who stand higher in the scale of fortune and rank, are too often but boors in intellect, are obstinate in their attachment to old practices, and are apt, when any of these are reprehended, to stop discussion by saying, '*Faccio come faceva la buon'anima di mio padre, e ciò basta*' (I do as my father, of blessed memory, did before me, and that is enough).

"The poor people of the country make culinary uses of the same oil that is exported, and which in England is only used in manufactures or burnt in lamps; but in the houses of the gentry I have often tasted oil prepared with more care, which was truly delicious, being equal to that of Sorrento, Vico, and Massa, or even to the best oils of Tuscany or Provence."

The *olea fragrans* is highly odoriferous, both in the leaves and blossoms, and on this account is much esteemed in China, where the leaves are used to adulterate and flavour tea.

CHAP. XXXVII.

TROPICAL FRUITS.

THE TAMARIND, *(Tamarindus Indica)*. Nat. ord. *Leguminosæ*, Linn. *Monodelphia triandria.*

134.

The Tamarind.

The name is of Arabic origin, *Tamar-kindy.* This tree is a native of Arabia and Egypt, and of the East and West Indies. It is a large, spreading, and beautiful tree; the leaves are abruptly pinnate, composed of sixteen or eighteen pairs of sessile leaflets; half an inch only in length, and one-sixth of an inch broad; of a bright green colour, downy, oblong, entire, and obtuse. The flowers are in loose bunches of five or six, which come out from the sides of the branches: the calyx is of a straw yellow colour, and deciduous; the petals are also yellowish, and beautifully variegated with red veins: the filaments are purplish, bearing incumbent brownish anthers. The pods are thick, compressed, and of a dull brown colour when ripe; those from the West Indies from two to five inches long, with two, three, or four seeds; those from the East Indies are twice as long, and contain five, six, or seven seeds: the seeds in both are flat, angular, shining, and lodged in a dark pulpy matter, which is the edible part of the fruit. In the West Indies the pods are gathered in June, July, and August, when fully ripe; and the fruit being freed from the shelly fragments is placed in layers in a cask, and boiling syrup poured over it till the cask is filled; thus the syrup pervades every part quite down to the bottom; when cool the cask is headed or closed in, and is now fit for sale. The East India tamarinds are darker coloured, and drier, and are said to be preserved without any addition of syrup. Tamarinds are inodorous, but they have a sharp, penetrating, and agreeable acid taste, softened by a sweetish one. The acid is chiefly the citric. The pulp is frequently employed in medicine; it is cooling, and gently laxative, and is peculiarly grateful in fevers and inflammatory diseases.

The tamarind tree is both useful and highly ornamental in those countries where it grows, and where its cool shade is nearly as much prized as its fruit. In this climate the plants thrive best in a peat or loamy soil, and root under a glass in sand. They rarely blossom here in our confined hot-houses.

About forty tons of tamarinds are annually imported into Great Britain.

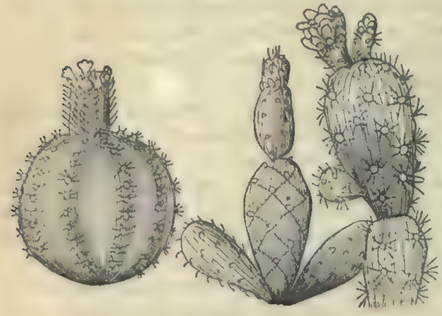
PRICKLY PEAR, *(cactus.)* The *cacti* form a natural family of peculiar plants. They belong to the *icosandria monogynia* of the Linnæan arrangement. Under the name of cactus, Theophrastus describes a spiney plant used as food, which grew in Sicily. The family consists of succulent plants, of perennial duration; generally without leaves, and having the stem or branches jointed. They are for the most part armed with spines in bundles, with which, in many species, bristles are intermixed. These bundles of spines are placed on the top of the tubercles, on the smaller melon thistle, which is tubercled all over, and produces its flowers between the tubercles. In the great melon thistle the spines are ranged in a single row on the ridge of ten ribs. These are of an ovate or globular form. Those on the torch thistle, on the contrary, are slender, rise up high, and are jointed and branched. Many of them are almost cylindrical, with from five to ten shallow ribs; some, however, are square or three cornered.

The structure of the creeping cereuses is the same with these, except that the stems are weak and cannot support themselves; they therefore seek support from trees, and throw out roots from the stem like ivy. In the Indian figs the branches are jointed, and flattened like the sole of a shoe. The bundles of spines or bristles are scattered over the surface, and the flowers are produced from the edge of the extreme branches. The leaves are alternate, flat, and thick, the prickles are large and stiff, and come out in bundles on the stalk and branches, chiefly at the axils. The flowers spring from the axils also, several together. In this species, and in the Indian fig, the flowers are pitcher-shaped. In the other species they are sub-cylindrical, and longer; in phyllanthus very long. The fruit in some of the sorts is small, like currants; but in most it is larger, and shaped like a fig, whence their name of Indian fig.

THE TURK'S CAP, or MELON THISTLE, *(cactus melocactus.)* This species appears like a large flesh green melon, with deep ribs, the elevations set all over with knots of strong sharp thorns. When divided through the middle the inside is found to be a soft, green, fleshy substance, very full of moisture. The flowers and fruit are produced in circles round the upper part of the cap. Some of those which have been brought to England have been more than a yard in cir-

cumference, and two feet and a half high, including the cap. But in the West Indies there

135.



The Melon Thistle.

are plants nearly twice this size. Linnæus remarks that this plant resembles a hedgehog in its form and spines, and on the top has a discoid, convex, villous body, from which the flowers proceed.

These plants grow out from the steep rocky mountain sides in the warmer parts of America, where they seem to be thrust out of the apertures of the rocks, having apparently little earth to support them; their roots shooting down the fissures to a considerable depth, so that it is troublesome to get the plants up. As they delight in such rocky places, they seldom live long when transplanted into a better soil. In times of great drought the cattle repair to the barren rocks where these plants grow, rip them up with their horns, tear off the outside skin, and greedily devour all the fleshy moist part. The fruit is frequently eaten by the inhabitants of the West Indies. It is about three quarters of an inch in length, of a taper form, drawing to a point at the bottom, but blunt at the top. The taste is an agreeable acid.

C. repandus has a fruit about the size and shape of a Bergamot pear, having many soft spines in the skin. The outside is a pale yellow, the inside very white, full of pulp, having a great number of small black seeds lodged in it. It frequently flowers in July; and in warm seasons will perfect its fruit, which has very little flavour in this country, but is frequently served up at table in the West Indian islands.

The Night-flowering Cactus, *(c. grandiflorus,)* as its name implies, produces flowers of great beauty and sweetness; they are very evanescent, however, like most of their kind, enduring at the most for not more than six hours. They begin to open between seven and eight o'clock in the evening, are fully blown by eleven, and by three or four in the morning they fade and hang down quite decayed, never opening again when once closed. During their short continuance there is scarcely any flower of greater beauty, or that makes a more magnificent appearance; for the calyx of the flower, when open, is nearly a foot in diameter, the inside of which being of a splendid yellow colour, appears like the rays of a bright star: the outside is of a dark brown; the petals being of a pure white, add to the lustre. The vast number of recurved stamens surrounding the style in the centre of the flower, make a fine appearance, while the delicious odour scents the air to a considerable distance. Few plants are more deserving of a place in the hothouse than this, especially as by training it against the wall it occupies little room. The usual season of its flowering is in July; and when the plants are large, many flowers will blow the same night, and there will be a succession for several nights together. Sometimes from six to ten flowers open on the same plant in one night, thus exhibiting a most magnificent appearance by candle light. In this country the fruit never forms.

Another species, the *flagelliformis*, produces a greater number of flowers than the preceding. They blow in May, or even earlier, in mild seasons. The petals are of a delicate pink colour, both outside and inside; their petals are not so numerous as in the other species, while the tube of the flower is longer. These flowers remain open for three or four days, provided there is not too much warmth; fruit sometimes succeeds the flowers, but seldom ripens. This species has slender trailing branches.

The Strawberry Pear, *(c. triangularis,)* bears the best flavoured fruit of any of the family. It is sweetish, slightly acid, pleasant, and cooling. In Martinique, and the other West India islands where it is cultivated, it is much esteemed.

The Indian Fig, *(cactus Opuntia,)* a native of the country of the Opuntiani, whose chief town

136.

The Indian Fig.

was Opus, in the vicinity of Phocis, though, like others of the same family, a native of America also, is now found growing wild on the sides of the

roads between Rome and Naples, and other parts of Italy, and even in the Valais; Gerarde says it was brought from Virginia into England, and Collinson had it from Newfoundland. It was fruited in Scotland in a stove, by Justice, in 1750, and recently by Braddoch, near London, in the open air. This active horticulturist having eaten with pleasure of the prickly pear in Virginia, was desirous of cultivating it here. He recollected that the plant in its wild state delighted in a dry soil, amongst rocks, near the skirts of the sunny sides of the forests, and having heard that it would stand the open air in this country, he planted it in a compost, prepared for the purpose, in a sheltered situation exposed to the sun. "The first plant," says he, "that I turned out, has lived in the open ground of this country for six or seven years, during which period it has experienced one exceeding hard winter, and several trying springs; and in all, except the two first years, it has never failed to ripen its fruit and seeds, so that it may now be considered decidedly acclimated. The compost which I used is as follows: One half is carbonate of lime, for which lime rubbish from buildings will answer; the remaining half consists of equal portions of London clay, and peat earth, having the acid neutralized by barilla; these are intimately blended and sifted. One square yard of this compost I conceive to be sufficient for one plant, which must be placed in the middle of a small artificial hillock, raised eighteen inches above the surface of the ground, which ground should be rendered perfectly dry, if not naturally so by under draining. Neither the leaves, flowers, or fruit, should ever be suffered to touch the ground; but they should, as constantly as they are produced, be kept from the earth by placing stones, pebbles, flints, or bricks under them, in imitation of artificial rock work.

The Indian fig is very common in Jamaica, and on it feed the wild sort of cochineal insect. The fruit is large, and of a deep purple colour, and when eaten stains the urine of a blood-red hue.

The Cactus Tuna is used as a hedge plant in Spain, South America, and the West Indies. When the island of St Christopher was to be divided between the English and the French, three rows of the tuna were planted by common consent between the boundaries. Sir J. E. Smith remarks, that the stamens of the flower are very irritable, and that if a feather be drawn through them, in two or three seconds they begin to lie down gently on one side, and in a short time become recumbent at the bottom of the flower.

The Cochineal Fig, *(c. cochinellifera,)* is the species on which the cochineal insect chiefly feeds, and is selected because it is least annoying by its prickles. This insect, however, does not confine itself entirely to the cacti, but feeds on other succulent plants. This species produces an edible fruit larger than that of the opuntia: on the top of the fruit there grows a red flower; this, when the fruit is ripe, falls down on the top of it, and covers it, so that no rain or dew can wet the inside. A day or two after, the flower being scorched up by the heat of the sun, the fruit opens wide, and the inside appears full of small red insects. The Indians, when they perceive the fruit open, spread a large linen cloth, and then with sticks shake the plant to disturb the insect, so that they take wing to begone; but keep hovering over the plant till from the heat they fall down dead on the cloth, where the Indians let them remain two or three days till they are dry. The cochineal plants are called by the Spaniards toona; and they are planted in the country about Guatimala, Chiape, and Guaxaca, in the kingdom of Mexico. The difference of quality in the cochineal, depends entirely on the plants on which the insects feed. The prickly pear, so abundant in Jamaica, is covered with the insects; but not having their proper food, they are in general diminutive, and have very little red tincture in their bodies. The delicate red coloured juice of the fruit is the natural food of the insect. Its exuviæ and animal salts are, from the minuteness of its body, inseparable from the essential principles of the dye, and tend to diminish somewhat the brilliancy of the colour. On this account attempts have been made to obtain the inspissated juice of the plant directly from itself.

The Pine Apple, *(bromelia.)* The natural family *bromeli* belongs to the second division of plants, or the monocotyledons; and we have reserved a description of it to this place, merely as it comes under the general denomination of pulpy fruits.

This fruit is somewhat of the shape and external form of the cone of the pine tree, hence its name of pine apple. It is without doubt the most delicious of all known fruits, and yet it has not been known in Europe above two centuries; nor is it more than half that period that its cultivation has been practised in Britain.

It is doubtful to what quarter of the globe we were first indebted for this fruit. The earliest exchanges of tropical plants that took place between the Portuguese in the East, and the Spaniards in the West, have not been recorded with perfect accuracy, so that we are not absolutely certain that the pine apple may not be a native of some parts of Asia, and even of Africa, as well as of America. That it is a native of the West is certain, however, as all the varieties, except some of the trivial ones arising from cultivation, are found wild on the continent or the islands of that quarter of the world.

The bromelias have been variously described; some having formed them into three or four dis-

tinct genera, and others considered them as only species of one. In the *hortus Kewensis*, in the formation of which the very best authorities have been consulted, six species are enumerated; and, with the exception of the *bromelia humilis* (dwarf,) they are all there represented as being natives either of South America or the West Indies. Only one of the species is of any value in cultivation, the others being merely wild plants. The cultivated species is the *ananas;* the others are the *pinguin*, or broad-leaved; the *karata*, or upright-leaved; the tongue-leaved, the red-breasted, and the dwarf.

In the form and combination of their leaves, all the bromelias have some resemblance to each other, and also to the aloe; but the only species in which the seeds are united into one fleshy and esculent strobile or pine, is the ananas.

The *pinguin* species have the leaves very short and strong about the root, and their edges are armed with strong crooked spines. The fruits are detached; each about the size of a walnut. The pulp is sweet, but it is at the same time so sharp as to be absolutely corrosive. A tuft of leaves growing above the fruit makes the pinguin look something like the pine apple, when seen at a distance; but the detached fruit soon distinguishes it upon a closer inspection. Though not edible, the pinguin is not without its use. It grows readily and abundantly in the West Indies, both on the fertile savannahs and the mountains. It is hardy, and is formidable with its spines, and thus it answers well for hedges. The fibres of the leaves too, are very tough and strong; and, when freed from the pulpy matter, they are made into ropes. A small portion of the juice mixed with water, forms a very cooling draught; and some of the varieties, which grow so plentifully about Campeachy that it is hardly possible to move amongst them, have their fruit in clusters, and are not unpalatable.

The *karata* grows in woods, under trees, both in the West Indies and on the continent of America. The leaves are six or seven feet long; the fruit of an oval form, and from two to three hundred in number upon a single plant. Before it is ripe the fruit is sour and acrid, but when ripe it is not unpleasant. Until the fruit is ripe it is defended by the spines of the leaves, so as to be quite secure against injury.

The tongue-leaved, the red-branched, and the dwarf, are smaller species. The first and second very much resemble some of the species of aloe in their forms, and are found in most of the West India islands.

The *ananas* or pine apple, properly so called, when of a good sort and healthy, is accounted the best, at least the most luscious, fruit that this country produces; and, with careful cultivation, is equal in quality to that of places where it is a native. It is said even to be superior, because the English gardeners may, by skilful treatment and choice of sorts, more than make up for the want of sun and the deficiency of natural temperature.

It has been said that the pine apple was brought from Brazil, first to the West Indies, and thence to the East; but the evidence is not complete. It was known in Holland some time before its introduction into this country; and even about its introduction here there are some disputes. The picture of king Charles II., with his gardener presenting him with a pine, said to be the first grown in England, is rejected by the better informed authorities; and the pine, if ever such a fruit was offered to that monarch, is supposed to have been brought from Holland, or the pine to have been presented, and the picture drawn, before his return to this country. Mr Bentinck, the ancestor of the duke of Portland, is, according to the best accounts, supposed to have first introduced and cultivated the pine in the year 1690; and this is rendered the more likely, from the fact that he was previously acquainted with the fruit in Holland. And yet the cultivation of the pine had made so little progress in England a quarter of a century later, that lady Mary Wortley Montagu, on her journey to Constantinople in 1716, remarks the circumstance of pine apples being served up in the dessert, at the Electoral table at Hanover, as a thing she had never before seen or heard of.

Pine apples have been grown in this country of an extraordinary size. One of the New Providence kind, that weighed nine pounds, four ounces, was presented to his Majesty in June, 1820, by John Edwards, Esq., of Rheola, Glamorganshire, where it was grown. In July, 1821, another Providence pine is mentioned, in the Transactions of the Horticultural Society, to have weighed ten pounds eight ounces: it was grown by Mr Buchan, gardener to Lord Cawdor, at Stackpool Court, Pembrokeshire. It was ten inches and a half high, exclusive of the crown and stalk, and twenty-two inches in circumference. From the extraordinary size and beauty of the fruit, it was thought proper by the Fellows of the Horticultural Society to present it to his Majesty, which was accordingly done; and it was served up in the dessert at the royal table at the Coronation banquet. Mr Buchan raised three other pines of extraordinary weight in the same season: one weighed ten pounds six ounces; another, ten pounds two ounces; and a third, nine pounds eight ounces; making the total weight of the four, forty pounds eight ounces.

In the Indian Archipelago, and in China, an extraordinary, monstrous state of the pine apple is sometimes seen, called the many-headed pine. It is caused by the plant producing branches bearing fruit at each point; where, under common circumstances, it produces single flowers. There

are specimens of this kind in the library and garden of the Horticultural Society of London.

As the pine plant is a triennial, bearing fruit once only, unlike the peach, and vine, and other fruit-bearing plants, its propagation, rearing, and fruiting, are necessarily all carried on in every garden where it is cultivated. Its culture generally commences in a common hot-bed frame, heated by dung. At the end of a period varying from six to nine months, it is removed to a larger framed hot-bed or pit, generally called a succession bed, or house; and after remaining there from eight to twelve months, according to circumstances, it is removed to its final destination, the fruiting bed, pit, or house. Here it shows its fruit, which continues in a growing state during a period varying from six to twelve months, according to the variety grown, and mode of culture; and finally ripens its fruit and dies, leaving the crown or terminal shoot of the fruit, and one or more suckers or side shoots as successors. The production of a single pine apple requires a course of exotic culture, varying from eighteen months to three years, and generally not less than two years. The pine is generally grown in pots; and as it requires a high temperature in addition to the heated air of the hot-house, it is plunged into a bed of hot fermenting bark or dung. A rich sandy loam is the fittest soil for it.

The Guava, *(psidium.)* This genus of tropical fruits belongs to the natural family *myrtaceæ*, and to the *icosandria monogynia* of Linnæus.

There are seven or eight species of the guava known to botanists; some natives of Asia, and others of tropical America.

The *white guava, (psidium pyriferum)* is the best, and also the most abundant in the West Indies. When wild, the white guava is a shrub rather than a tree, as it seldom exceeds eight or nine feet in height; but, when introduced into gardens, it attains the size of an ordinary apple-tree, with a trunk about six feet high, and six inches in diameter. The wood is very hard and tough; the leaves are from two to three inches long, and grow in pairs opposite each other; the flower is white, and has a very agreeable flavour; the fruit is rather bigger than a hen's egg, of a sulphureous yellow, very smooth, and has a peculiar smell; it is covered with a rind of some thickness, within which are the seeds, contained in a pulp without any shell. The pulp is flesh-coloured, sweet, aromatic, and very grateful to the palate. It is used as a dessert fruit, and also preserved with sugar; and guava jelly is esteemed one of the finest conserves that come from the West Indies. By proper culture it may be brought to be a large and handsome tree; but when wild, it remains shrubby, and overruns the land.

The *red guava (psidium pomiferum,)* is a much larger tree than the white; the trunk often attaining the height of twenty feet. On poor soils, however, it is apt to be rugged and shrubby. The leaves are of a light green; the flowers white; the fruit shaped like a pomegranate, and having an agreeable odour when ripe. As a fruit, however, many of the authorities represent it as being very much inferior to the white guava; but it is probable that they have found it in the wild state, for it appears to be much improved by culture.

The mountain guava, found in the woods of Jamaica, is not much esteemed as a fruit tree; but it grows to a large size; the wood is of a beautiful dark colour, finely curled, easily worked, susceptible of a high polish, and therefore much valued as a timber tree.

In a paper read to the Horticultural Society, Mr Cattley, of Barnet, gives an account of a previously undescribed species of guava. The fruit is nearly spherical, of a fine deep claret colour, growing at the insertion of the leaves, and contains from twenty to thirty seeds, inclosed in a pulp, which is sweet, and slightly acid. Independently of the value and beauty of the fruit, this is a highly ornamental plant, may be propagated freely by cuttings, and bears at the age of eighteen months. It is understood to have come from South America, and has an external texture resembling the fig: its internal consistence and flavour bear a considerable resemblance to those of the strawberry. With proper treatment, it is one of the most free growing of all the tropical fruits.

This guava, which has received the name of *psidium cattleyanum*, promises to become a very valuable addition to stone fruits; and, both for its appearance and its flavour, merits attention. There is a specimen in one of the hot-houses belonging to the Horticultural Society, which is a thriving and elegant tree. It is about ten feet high, and trained something in the fan shape, till the outside branches have a width of sixteen feet. The bark of the tree is of a soft ash colour, with a very slight trace of brown, and smooth, but not glossy. The leaves are beautiful and vigorous, the blossoms abundant. That the fruit would, properly managed, come to the same maturity in the average of situations in this country, as in those places of which it is a native, there cannot be the least doubt; and it has this advantage over most other fruit trees, whether indigenous or exotic, that it produces two crops in the year.

The Akee, *(blighia sapida.)* *Octandria monogynia* of Linn.

This is a native of Guinea, from whence it was carried to Jamaica by Captain Bligh in 1793. It has grown well in the West Indies, and is there much esteemed as a fruit. It was

introduced into England in 1793. The leaves of the akee are something similar to those of the ash: the flowers are small and white, and are produced in branched spikes. The fruit is oblong, ribbed, and compressed in the middle, of a dull orange colour, and contains several large seeds, to the end of which is attached a rich and slightly acid arillus (the outer coat of a seed lightly attached to it), which is the part eaten.

The Negro Peach, or Edible Peach. The tree on which the negro peach is produced is very handsome, with lanceolate leaves, resembling those of the orange. The flowers are white, and grow closely clustered in little round heads, like those of the American button wood, so common in shrubberies. The tree has flowered in the gardens of the Horticultural Society, but has not borne fruit in this country. The fruit is about the size of an ordinary peach, but very different in colour and qualities. Externally and internally it is brown, of varying shades: its form is irregular, and the whole surface covered with tubercles. About one-third of the diameter in the centre consists of a very firm and somewhat dry pulp, of a flavour resembling an apple. Between that and the rind, the pulp is of softer consistency, full of seeds and fibres, and has a flavour resembling the strawberry.

Monkey's Bread (*Adansonia digitata*). This tree, known as the celebrated *baobab*, is a native of the western coast of Africa, and also of Egypt. In the former country it is described

137.

Monkey's Bread.

by Adanson as being a tree of large dimensions and singular economy. The trunks were about twelve or fourteen feet high, but of the vast circumference of sixty or seventy feet. The lateral branches were forty or fifty feet long, of the thickness of a great tree, and with their remote branches touching the ground; while some of the roots that had been laid bare were upwards of a hundred feet long, and even then were not exposed for their whole length. The fruit is from nine to twelve inches long, and about four in diameter, of a brownish colour, and rather pointed toward the extremities. The pulp is a little farinaceous, mixed with fibres: when recent, it has a very refreshing, acid taste; and eaten with sugar, it is both pleasant and wholesome. It retains its cooling qualities when dry; and, on that account, the physicians of Cairo administer it in fevers and other diseases.

We shall have occasion to describe this curious tree more minutely afterwards.

The Mango (*Mangifera indica*). Natural order *terebinthaceæ; Pentandria, Monogynia*, of Linn.

The mango is a large spreading tree like the walnut, with lanceolate, shining, green leaves, seven or eight inches long, having a sweet resinous smell. The flowers are white, growing in bunches at the extremity of the branches: the fruit has some resemblance to a short, thick cucumber, and on the average of the varieties, of which there are many, about the size of a goose's egg. At first the fruit is of a fine green colour, and in some of the varieties it continues so, while others become partly or wholly orange. When ripe, the mango emits a smell, which, though faint is very pleasant; and the flavour of it is then as delicious as can be imagined. Externally there is a thin skin; and upon removing that, a pulp, which has some appearance of consistency, but which melts in the mouth with a cooling sweetness, that can hardly be imagined by those who have not tasted that choicest of nature's delicacies. In the heart of the pulp there is a pretty large stone, resembling that of a peach, to which the pulp adheres firmly.

It is a native of Asia and its islands, as well as Brazil. The mangos of Asia are said to be superior both in size and flavour to those of America; and so highly are some of the finer trees prized in India, that guards are placed over them during the fruit season. The mangos of Mazagong, which are thus carefully watched, are thought to be superior to any other. The varieties of a fruit so much esteemed must be numerous; accordingly it is reckoned that there are upwards of forty in the island of Java alone, while those of some of the islands farther to the east, such as Amboyna and Banda, are said to be still finer. The *mango dodol* is the largest variety, the fruit weighing upwards of two pounds; generally about the size of a middling shaddock. Some of the others, which make up the five principal heads into which Rhumphius (*herbarium amboinense*), arranges the whole, are of superior size and flavour; but the fruit, taken alto-

gether, is one of the chief dainties of the vegetable world.

The mango is never brought from India to this country in any other state than the green fruit pickled, from which no idea of the flavour can be formed. The ripe fruit is very perishable; and when it begins to decay it is offensive, and tastes strongly like turpentine. It is not easy even to secure the vegetative power of the nut or kernel during the voyage from India, unless it be inclosed in wax; and the plants are with difficulty preserved as objects of curiosity.

In the Transactions of the Horticultural Society for 1826, there is an account of some mangos, raised by Earl Powis, at Walcot Hall, in Shropshire. "The mango," says Mr Sabine, the secretary to the society, in his very able paper upon the subject, "is well known to all travellers who have visited the tropical parts of the world, as being by far the best fruit that is generally produced in those regions, and as that which is the most uniformly grateful to an European palate. In such climates, it is cultivated wherever the arts of civilization have penetrated; and it may there be said to hold the same station, among other fruits, as the apple possesses among those of northern regions. Like the apple, the number of varieties raised from the seed of the mango is also very great; and of these, while some possess the highest excellence, there are others in which the flesh of the fruit is so fibrous and ill-flavoured, as to resemble, as is commonly said, nothing so much as a mixture of 'tow and turpentine.' "

The Mangostan, *(garcinia mangostana)*. The mangostan, or mangustin, is one of the most delicious fruits that grows; and the tree on which it is produced, is one of the most graceful and beautiful anywhere to be met with. It is a native of Sumatra, and also of the Molucca, or Spice islands, from which it has been transplanted to Java, and some other parts of the eastern Archipelago. The stem, which is of a variegated brownish-red colour, rises to the height of about twenty feet; the branches come out in regular order, and give the head of the tree the form of a parabola; and the leaves are entire, about eight inches long, and four broad at the middle, of a beautiful green on the upper side, and a fine olive on the under. The flower resembles that of a single rose, with some dark red petals. The fruit is round, about the size of an ordinary orange; and has a little cap on the extremity, under which it is plaited into rays. The shell of the fruit, which is at first green, but changes to brown marked with yellow spots, has some resemblance to that of a pomegranate, but is thicker and softer, and the contents are more juicy. The pulp is divided internally by thin septa, like those in an orange, and the seeds are lodged in the divisions. The flavour of the pulp is said to be that of the finest grape and strawberry united; but those who have tasted the fruit in perfection, and attempted to convey to others some idea of the impression that it had made on them, are not agreed as to what it resembles. Abel says that "he and his companions were anxious to carry with them some precise expression of its flavour; but after satisfying themselves that it partook of the compound nature of the pine apple and the peach, they were obliged to confess that it had many other equally good but utterly inexpressible flavours."

There are two other species of this tree. These are the Celebes mangostan *(garcinia celebica,)* and the horny mangostan *(garcinia cornea.)* The first is found wild in the woods of Celebes, near Macassar, whence it has been transplanted to Amboyna, Java, and other places; but the fruit, which is rather larger than that of the true mangostan, does not always ripen. The corneous species is found in the high remote mountains of Amboyna: it is a lofty tree, though not of very great diameter. The fruit is so excellent as nearly to equal the true mangostan. The wood is very hard, heavy, and tough, and of the colour of horn, from which latter circumstance the specific name is given to it.

All the sorts may be propagated from seed, layers, and even cuttings; but layers come soonest into bearing, producing fruit generally the second year. The seedlings of the purple-fruited sort, will produce fruit the first year. All the species will bear fruit even in large pots; but, according to Sabine, the best method is to plant them in a corner of the bark bed. They flourish best in a temperature from 60° to 70°.

The Durion, *(durio zibethinus.) Polyadelphia polyandria* of Linn.

The durion, which is pretty generally diffused over the south-east of Asia, is accounted next to the mangostan; and, in the opinion of some, is superior to it. However excellent the taste may be, the durion is revolting to those unaccustomed to it; for it has a strong smell, which is said to arise from sulphuretted hydrogen. Yet this quality is soon forgotten, after the palate becomes familiar with it. Though of the most nutritious quality, and the most dainty taste, the durion never palls upon the appetite or injures the digestion: its effects are directly opposite.

The tree which produces the durion is about the size, and something in the form of a pear tree; but the leaves are in shape like those of the cherry, only they are entire and smooth at the edges. The flowers are large, and of a yellowish white. The fruit is large, in some of the species as large as a man's head; and, externally, it is not unlike the bread fruit. It has a hard rind, covered with warts and tubercles. When ripe, it becomes of a brownish yellow, and opens at

the top. It must then be eaten fresh from the tree, as it putrifies in less than twenty-four hours.

Internally, the fruit contains five large longitudinal cells, in each of which are the seeds, about the size of pigeon's eggs, and from one to four in each cell. The remainder of the cells is filled with the pulp, which is the delicious part of the fruit. It is of the consistence of thick cream, of a milk-white colour, highly nutritious, and blending the flavour and qualities of a delicate animal substance with the cool acidity of a vegetable. This compound flavour is peculiarly its own, and cannot be imitated by any process of cookery. The Spanish *mangia blanco*, pullet's flesh distilled with vinegar, is said to come the nearest to it.

The durion is a particular favourite with the natives of the eastern archipelago; and there are many varieties of it. They all, however, belong to three principal ones:—The *borneo* durion is found in the island after which it is named. It grows to so great a size, that one fruit is a load for a man. The *cassomba*, which has a smoother rind, is more orange in the colour, more elongated in the shape, and contains fewer seeds and more pulp. The *babi* is a small, but very delicious sort. The kernels or seeds of the durion, when roasted, have nearly the same taste as chestnuts. It has not been found in a wild state; but in the countries where it will grow and ripen at all, it is easily cultivated. So highly is it esteemed, that it is the most costly fruit in the archipelago, a single durion being worth more than a dozen of the choicest pine apples.

The *lanseh*, and the *jamlee*, fruits of Sumatra, are esteemed most highly by the natives, the former next to the durion.

The Malay Apple (*Eugenia malaccensis*). This, though an inferior fruit to the durion, is attractive by its fragrance, its smell being that of a rose. The Malay apple belongs to a numerous genus of plants, there being a great number of species very generally diffused over the tropical countries. The fruit of all the species is a fleshy rind, inclosing one or two large seeds. The Malay apple varies in size from about an inch in diameter to the bigness of a man's fist. The skin is yellowish, thin, and shining; the nut large, and without any hard shell; and the pulp very wholesome and agreeable. The tree that produces it has a brown stem, about twenty feet high, very full of branches at the top. The young leaves are bright purple, and the old ones green.

The Rose Apple, or *Jamrosade* (*Eugenia jambos*). This is a branching tree, from twenty to thirty feet in height, with long narrow leaves, resembling those of the peach. The flowers come out in terminal bunches in July, are of a greenish yellow colour, and succeeded by fruit about the size of a hen's egg; white, red, or rose-scented, with the flavour of a ripe apricot. It is a native

139.

The Rose Apple.

of the East Indies, and was cultivated in England, by Millar, in 1768.

Litchi (*dimocarpus litchi*)—Longan (*dimocarpus longan*). These fruits are natives of the south of China, where they are held in the highest estimation. They have thence been introduced into many parts of the East Indies, and to the gardens of the curious in some places of Europe. John Knight, Esq., of Lee Castle, near Kidderminster, presented the Horticultural Society with some of the fruit that had ripened in his hot-house in 1816, and it was found to be as good as that which is produced in China. The litchi was introduced into this country by the celebrated Warren Hastings, Esq., in 1786: the longan had been introduced before.

The trees on which these fruits are produced have a considerable resemblance to each other; are in fact so much alike, that they are distinguished only by the flowers of the litchi being without petals, while those of the longan have eight; and the fruit of the litchi being larger, and generally of a red colour, while that of the longan is always brown. They are moderately sized trees, with brown bark, which is very bright in the twigs. The leaves are large, have some resemblance to those of the laurel, are placed alternate, and hang very gracefully. The fruit is produced in bunches, which are pendent from the extremities of the twigs; and there is a considerable number of fruit in the bunches, not close together, like grapes, but on stalks, the principal ones from six inches to a foot in length; while those of the individual fruit are from one inch to two.

Of both species there are many varieties in China, which differ in the time of ripening, and the form and qualities of the fruit. In general, the litchi is about an inch and a half, or from that to two inches, in diameter, and the longan about an inch and a quarter; and both are covered with small scaly processes, which are most prominent in the longan. Both fruits are covered by tough, thin, leathery coats, within which is the pulp, and in the inside of that a single brown seed. The pulp is colourless, semi-transparent, slightly

sweet, and very grateful to the taste. The Chinese prefer the longan, to which they ascribe medicinal qualities; but Europeans give the preference to the litchi, probably on account of its larger size, and the greater beauty of its colour. The litchi is often brought to this country in a dried state, in which, though the pulp be much diminished in size, it retains a very considerable portion of its original flavour. From the beauty and flavour of these fruits, and the perfection to which they have been brought in this country, in all cases where they have had a fair trial, it is by no means unlikely that they may become common as hot-house fruit.

THE JUJUBE *(zizyphus jujuba)* belongs to the very numerous genus of the buckthorns *(rhamni)*. It is found in the south of Europe; but no where is it brought to so much perfection as in China, where there are upwards of sixty kinds, all of them highly esteemed. In the opinion of Mr Lindley (Trans. Hor. Soc. v. 123), the Chinese jujube might be fruited in greenhouses in England, with a very moderate degree of artificial heat.

THE KAKI, or *Chinese Date-Plum (diospyrus kaki)*, is a tree of a middle size, bearing a fruit about the size of an apple, of a reddish orange colour, and with a very luscious, brownish, semi-transparent pulp. The fruit of one species is dried with sugar, like figs.

THE BREAD-FRUIT *(artocarpus incisa)*. This celebrated tree belongs to the natural family

140.

Bread Fruit.

urticeæ, and to the class and order *monœcia monandria* of Linnæus. The bread-fruit, originally found in the south-eastern parts of Asia and the islands of the Pacific, though now introduced into the tropical parts of the western continent and the West India islands, is one of the most interesting as well as singular productions of the vegetable kingdom. There are two species of it: the bread-fruit, properly so called *(artocarpus incisa*, fig. *a)*, with the leaves deeply gashed or divided at the sides, which grows chiefly in the islands; and the Jack fruit, or Jaca tree *(artocarpus integrifolia*, fig. *b)*, with the leaves entire, which grows chiefly on the main land of Asia.

The bread-fruit is a beautiful as well as a useful tree. The trunk rises to the height of about forty feet, and, in a full grown tree, is from a foot to fifteen inches in diameter; the bark is ash-coloured, full of little chinks, and covered by small knobs; the inner bark is fibrous, and used in the manufacture of a sort of cloth; and the wood is smooth, soft, and of a yellow colour. The branches come out in a horizontal manner, the lowest ones about ten or twelve feet from the ground, and they become shorter and shorter as they are nearer the top. The leaves are divided into seven or nine lobes, about eighteen inches or two feet long, and are of a lively green. The tree bears male and female flowers, the males among the upper leaves, and the females at the extremities of the twigs. When full grown, the fruit is about nine inches long, heart-shaped, of a greenish colour, and marked with hexagonal warts, formed into facets. The pulp is white, partly farinaceous and partly fibrous; but when quite ripe, it becomes yellow and juicy. The whole tree, when in a green state, abounds with a viscid milky juice, of so tenacious a nature as to be drawn out in threads.

THE JACA *(artocarpus integrifolia)*. The *Jaca*, or *Jack*, grows to the same, or even to a larger size, than the bread-fruit of the Society islands; but it is neither so palatable nor so nutritious. Though its specific name implies that it is entire-leaved, the leaves of it are sometimes found lobed like those of the other. The fruit often weighs more than thirty pounds, and contains two hundred or three hundred seeds, each of them four times as large as an almond. December is the time when the fruit ripens; it is then eaten, though not much relished; and the seeds or nuts also are eaten, after being roasted. There are many varieties of the jaca tree, some of which can hardly be distinguished from the seedling variety of the true bread-fruit. The fruit, and also the part of the tree on which it is produced, varies with the age. When the tree is young, the fruit grows from the twigs; in middle age it grows from the trunk; and when the tree gets old, it grows from the roots. The sort called the *champadak* is more esteemed than the common *Jack* or *Nangka*.

In the island of Otaheite and other places, where the bread-fruit forms the chief support of the people, there are, as is the case with cultivated vegetables in all countries, many varieties; only two, however, are very different from each other—that which contains seeds in the fruit, and that which contains none. The variety with seeds is much inferior to the other, being more fibrous, containing less farina, and not so pleasant to the taste; it is, therefore, not cultivated, though, in cases of need, it is roasted and eaten. Whether the seedless sort has been produced wholly by cultivation it is not easy, and would

not be of much importance, to ascertain. It is the one cultivated in the South Sea islands; it was originally found only there; and the tree was not in much repute till these islands were discovered.

The bread-fruit continues productive for about eight months of the year. Such is its abundance, that two or three trees will suffice for a man's yearly supply; a store being made into a sour paste, called *make* in the islands, which is eaten during the unproductive season. The planting of the seedless variety is now saved, as the creeping roots send up suckers which soon grow to trees. When the fruit is roasted till the outside is charred, the pulp has a consistency not very unlike that of wheaten bread; and the taste is intermediate between that of bread and roasted chestnuts. It is said to be very nourishing, and is prepared in various ways.

The timber of the bread-fruit, though soft, is found useful in the construction of houses and boats; the male flowers dried, serve for tinder; the juice answers for bird-lime and glue; the leaves for packing and for towels; and the inner bark, beaten together, makes one species of the South sea cloth.

The earliest account of the bread-fruit is by Captain Dampier, in 1688. "The bread-fruit," says this navigator, "grows on a large tree, as big and high as our largest apple trees. It hath a spreading head, full of branches, and dark leaves. The fruit grows on the boughs like apples; it is as big as a penny loaf, when wheat is at five shillings the bushel; it is of a round shape, and hath a thick tough rind. When the fruit is ripe, it is yellow and soft, and the taste is sweet and pleasant. The natives of Guam use it for bread. They gather it when full grown, while it is green and hard; then they bake it in an oven, which scorcheth the rind, and maketh it black; but they scrape off the outside black crust, and there remains a tender thin crust; and the inside is soft, tender, and white, like the crumb of a penny loaf. There is *neither seed nor stone* in the inside, but all of a pure substance, like bread. It must be eaten new, for if it be kept above twenty-four hours, it grows harsh and choky; but it is very pleasant before it is too stale. This fruit lasts in season *eight months* in the year, during which the natives eat no other sort of bread kind. I did never see of this fruit any where but here. The natives told us that there is plenty of this fruit growing on the rest of the Ladrone islands; and I did never hear of it any where else."

The scientific men who accompanied Captain Cook in his voyages, came home with the most enthusiastic ideas of the bread-fruit. Dr Solander calls it "the most useful vegetable in the world," and urges that no expense should be spared in its cultivation. The mere idea of bread, the most valuable food of man, growing spontaneously, was doubtless calculated to excite attention—almost, perhaps, as strongly as the subsequent description of the poet:—

"The bread-tree, which, without the ploughshare yields
The unreap'd harvest of unfurrow'd fields,
And bakes its unadulterated loaves
Without a furnace in unpurchased groves,
And flings off famine from its fertile breast,
A priceless market for the gathering guest." *

A tree, of the value and easy culture of which so very encouraging accounts were given, could not but attract the notice of the public generally, and more especially of those colonists of Great Britain who lived in a climate warm enough for its cultivation. An application to be furnished with plants of the bread-fruit tree was accordingly made to his late Majesty by the planters and others interested in the West Indies, and it met with a favourable reception. The Bounty, a vessel of about two hundred and fifteen tons burthen, was fitted up for a voyage to Otaheite. Lieutenant (afterwards Admiral) Bligh, who had accompanied Cook on his last voyage, and shown himself an officer of great talents, enterprise, and bravery, was appointed to the command. In addition to the crew of the vessel, two men were appointed, at the recommendation of Sir Joseph Banks, to take immediate charge of the procuring, shipping, and tending of the plants.

The Bounty was skilfully fitted up for her intended purpose. A large cabin between decks, in midships, was prepared for the reception of the plants. This had two large skylights on the top for light; three scuttles on each side for ventilation of air, and a double bottom; an upper one of timber on which to place the pots and tubs containing the plants, which was drilled full of holes to allow escape to the superfluous water which might have injured them by stagnation, and a leaden one upon the lower deck, in which the water that ran through the other was collected, and from which it was conducted by a leaden pipe at each corner, into casks below for future use.

Thus prepared, the vessel put to sea about the middle of November, 1787, but was beat about and baffled by contrary winds, so that the voyage was not commenced till the 23d of December. The instructions given to Lieutenant Bligh were full and explicit. He was to resort to those places in the Society isles where Captain Cook had stated that the bread-fruit tree was to be found in the greatest luxuriance, and there procure as many plants as the vessel could carry; after which he was to proceed with them to the West Indies with all possible expedition.

* Byron.

The commander sailed first for Teneriffe, and thence for the south of America, intending to enter the Pacific by the passage of Cape Horn. But the storms of that inhospitable region beat him back, and he was forced to bear away for the Cape of Good Hope, and reach the Society islands on the side of New Holland. This voyage, which had occupied ten months, terminated on the 25th of October, by the arrival of the Bounty at Otaheite.

No time was lost in putting the instructions into execution. The young shoots that sprung from the lateral roots of the bread-fruit trees were taken up, with balls of earth, where the soil was moist; and this operation was continued till they were in possession of one thousand and fifteen live plants, secured in seven hundred and seventy-four pots, thirty-nine tubs, and twenty-four boxes. To complete this cargo took them till the 3d of April, 1789; and Bligh sailed on the 4th, passing from Otaheite through the group of islands, and bidding adieu to the natives, with whom he and his crew had been on the most friendly terms during their stay.

Hitherto there had been no perils to contend with but those of the sea; but when four and twenty days had elapsed, and they were, of course, far from any land, a new scene took place, which frustrated for a time the bounty of the government and the skill of the commander. Under the cloak of fidelity, a mutiny had been forming of a very determined and extensive nature; and so well had the mutineers disguised their intentions, that not one but those who were in the plot had the slightest suspicion of it.

The known bravery of Lieutenant Bligh made the mutineers afraid to attack him awake; and so, on the morning of the 28th of April, he was seized, while asleep in his bed, by a band of armed traitors, and hurried upon deck in his shirt; and on coming there, he found the master, the gunner, one of the master's mates, and Nelson the botanist, who had been with him under Cook, confined in the fore hatchway, and guarded by sentinels. The launch was hoisted, and such individuals as the mutineers did not like were ordered to quit the ship, and forced if they refused or hesitated. Eighteen individuals, out of the forty-six, remained true to the commander; and one of them, Mr Samuel the clerk, contrived to save Mr Bligh's commission and journals; but he failed in attempting to procure Bligh's surveys, drawings, and remarks during fifteen years, which were exceedingly valuable, and the time-keeper. Four of the men, who kept their allegiance, were detained by the mutineers contrary to their wishes. The cause of this singular mutiny, for which none of the usual motives could very well account, could not with certainty be known; but it was generally supposed that the instigator was Mr Christian, one of the master's mates. Bligh himself says, in his most interesting account of this voyage and mutiny, "It will naturally be asked what could be the cause of this revolt? In answer, I can only conjecture that the mutineers had flattered themselves with the hope of a happier life among the Otaheitans than they could possibly enjoy in England."

Thus, after they had made certain of the successful termination of an enterprise which was looked upon with a great deal of interest, both in a scientific and an economical point of view, Bligh was disappointed; and he and his faithful associates were sent adrift upon the wide ocean, in an open boat, with only an hundred and fifty pounds of bread, a few pieces of pork, a little wine and rum, a quadrant and compass, and a few other implements of navigation. But they were undaunted, and they were skilful; and though they had hard weather to contend with, they reached Tofoa, one of the Friendly islands. But as the people there were as treacherous, though not quite so successful in their treachery, as their former shipmates, they again put to sea, and stood for New Holland, which they reached in safety, rested for a little, and got a supply of provisions. From New Holland they again sailed in the direction of the Eastern Archipelago; and after suffering the greatest fatigue, being exposed to the full action and vicissitudes of the elements, and forced for some time to bear famine, they reached the Dutch settlement of Coupang, in the island of Timor, without the loss of one individual by disease, though they had traversed at least five thousand miles of sea. Nay, so ardent was Bligh as a seaman, that, amid all those perils, he was occupied in making some very valuable observations.

The Dutch governor of Coupang showed them every attention; and from the care that was taken of them, twelve were enabled to return to England. Though the adventure had failed, every body was disposed to bestow all praise on the adventurer; and he was promoted to the rank of captain, and appointed to the command of his Majesty's ship Providence, in order to repeat the voyage.

The Providence, with the Assistant, a small ship in company, sailed on the 3d of August, 1791. His instructions were to procure the bread-fruit trees for the West Indies, and on his return, to examine the passage between the north of New Holland and New Guinea—which, in his former voyage in the Bounty, he had been the first to navigate.

On the ninth of April, 1792, they reached Otaheite; and by the 17th of July they were ready to leave the island, having on board twelve hundred and eighty-one tubs and pots of plants, all in the finest condition. There was no mutiny on this voyage; but the passage between New Holland and New Guinea was dangerous; and

it was the 2d of October before the captain reached his old friends at Coupang. He remained there for a week, replacing with plants from that island those that had died on the voyage; and then he came to the Atlantic by the Cape of Good Hope, which he contrived to pass so closely, as never to have a lower temperature than sixty-one degrees of Fahrenheit.

On the 17th of September he anchored at St Helena, collected there a number of trees, and among others the akee; and leaving twenty-three bread-fruits, and some other valuable plants, he sailed, and reached St Vincent on the 23d of January, 1793—where he left with Dr Anderson, the superintendent of the botanical garden, three hundred and thirty-three bread-fruit trees, and two hundred and eleven fruit trees of other kinds, receiving at the same time nearly five hundred tropical plants for the botanical garden at Kew. From St Vincent, Captain Bligh sailed for Jamaica, where he left three hundred and forty-seven bread-fruits, and two hundred and seventy-six others, which were a selection of all the finest fruits of the east. Some of the plants were also left on the island of Grand Cayman; and the ships finally came to the Downs on the 2d of August, 1793.

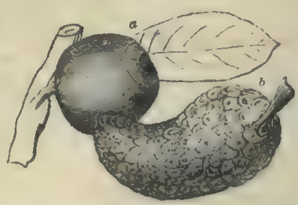
But after all the peril, hardship, and expense thus incurred, the bread-tree fruit has not, hitherto at least, answered the expectations that were entertained. The banana is more easily and cheaply cultivated, comes into bearing much sooner after being planted, bears more abundantly, and is better relished by the negroes. The mode of propagating the bread-fruit is not, indeed, difficult; for the planter has only to lay bare one of the roots, and mound it with a spade, and in a short space a shoot comes up, which is soon fit for removal.

Europeans are much fonder of the bread-fruit than negroes. They consider it as a sort of dainty, and use it either as bread or in puddings. When roasted in the oven, the taste of it resembles that of a potato; but it is not so mealy as a good one.

The Otaheite Hog Plum *(spondias cytherea)*. The tree which bears this fruit is large and graceful, rising to the height of fifty feet, spreading and shadowy. The fruit is oval, of considerable size, a fine golden yellow when ripe, very smooth, disagreeable to the smell, but having a fleshy pulp, and a great stone covered with fibres, which penetrate the flesh. It is peculiarly grateful from its cooling, and, at the same time, aromatic qualities, and its flavour very much resembles that of the pine apple. It is a very beautiful tree when in fruit. The leaves are of a dark clear green, among which the smooth fruit hangs in clusters, like burnished gold.

The Mammee *(mammea Americana)*. The mammee is a native of the West Indies, where it grows to a large tree, sixty or seventy feet in height. It is a handsome straight-growing tree,

141.



a The Mammee. *b* The Custard Apple.

with a spreading head, and the leaves are oblong and obtuse, with very many fine, closely set, parallel veins. The fruit of the mammee is yellow, not unlike one of the largest russet apples, either in shape or in size. The skin, which easily peels off, and the seeds, of which there are two or three in the centre, are resinous, and very bitter; but the pulp under the skin, which, when ripe, is of a deep yellow, resembling that of the finest apricot, and of considerable consistency, is very fragrant, and has a delicious flavour. It is eaten raw alone, or cut in slices, with wine and sugar. To people with weak stomachs it is said to be more delicious than healthful; but still it is highly prized, very abundant in the West India markets, and accounted one of the best native fruits they have. The mammee was found by Don in the vicinity of Sierra Leone; but whether native there, or imported from America, cannot be ascertained. It was introduced into England, in 1739, by Miller.

The Alligator Pear *(laurus Persea)*. The avocado, or alligator pear, grows upon a tree about the size of the common apple. It is a native of the West Indies. The leaves are oblong and veiny, the flowers of a yellowish green colour, and the fruit, which is the size of a large pear, is considered the most delicious in the world. It contains a kernel, inclosed in a soft rind; and the yellow pulp, which is firm, has the delicate rich flavour of the peach, but infinitely more grateful. It is sometimes called Vegetable Marrow, and is eaten with pepper and salt. It appears necessary, on account of the richness of the pulp, to apply some spice or acid, and thus lime-juice is also frequently added to it, mixed with sugar. Of the three kinds, the red, the purple, and the green, the latter is the best. The fruit is eaten with avidity, not only by men, but by birds and quadrupeds.

The Anchovy Pear *(grias cauliflora)*. The anchovy pear is a fruit also much esteemed in the West Indies, of which islands it is a native. The tree on which it grows is tall, upright, and handsome, rising to the height of about fifty feet, with leaves two or three feet long. It bears large whitish flowers, that come from the stem;

and these are followed by the fruit, which is of considerable size, brownish, having a kind of pulp over a single oval kernel. The fruit very much resembles the mango in taste; and, like that, it is often made into pickles before it is ripe. The tree grows in the moist parts of Jamaica, and other places of the West Indies; where, in addition to the value of its fruit, it is a highly ornamental tree. It may be reared in England, by the joint effects of bark and the heat of a stove, as is done with the pine apple. In the West Indies it grows readily from the kernel, and is often cultivated in clumps.

THE CUSTARD APPLE *(anona muricata, anona squamosa)*. Ten or twelve species of the custard apple are enumerated. They are natives of the tropical parts of Africa, Asia, and America; but the better sorts are more abundant in the latter part of the globe.

The Sour Sop, rough custard apple *(anona muricata)*, is a middle-sized tree, growing abundantly on the savannahs in Jamaica, and bearing a large oval fruit of a greenish yellow colour, covered with small knobs on the outside, and containing a white pulp, having a flavour compounded of sweet and acid, and very cooling and agreeable. It is, however, too common to be much esteemed by the wealthier people, though it is much sought after and relished by the negroes. The odour and taste of the whole plant are very similar to those of the black currant. It was early introduced into England, but has not come into cultivation as a fruit tree.

The Cherimoyer (anona cherimolia) is a native of the continent of America; and in Peru it is accounted one of the best fruits they have. Humboldt speaks of it with high praise; but Feuillée, another traveller in South America, says, an European pear or plum is worth all the cherimoyers of Peru. The tree which produces this fruit has a trunk about ten feet high; the leaves are oval, and pointed at both ends; the flowers are solitary, very fragrant, and of a greenish colour; the fruit of considerable size, somewhat heart-shaped, rough on the outside, and grayish brown, or even nearly black, when ripe. The flesh, in which the seeds are contained, is soft, sweet, and pleasant, and highly esteemed both by natives and foreigners. It has been introduced into England for about a century, but not cultivated as a fruit tree. In the South of Spain it is occasionally found in gardens, where it bears its fruit as an orchard tree.

The Sweet Sop (anona squamosa) is a very small tree, being, in many situations, little better than a bush. It is found both in the East and the West Indies. The fruit is almost the size of the head of an artichoke, scaly, and of a greenish yellow colour. The rind is strong and thick; but the pulp is delicious, having the odour of rose-water, and tasting like clotted cream mixed with sugar. It is, like many other fruits, said to have a much finer flavour in the Indian Archipelago than in the West Indies. It, too, was early known in England, but has not become general.

The Alligator Apple (anona palustris) grows wild in the marshes of Jamaica. The fruit is shining and smooth in appearance, and sweet and not unpleasant to the taste; but it is a strong narcotic, and, therefore, not generally eaten. One thing worthy of remark is, that the wood of the alligator apple tree is so soft and compressible, that the people of Jamaica call it cork-wood, and employ it for stoppers.

WILD PLUMS *(achras)*. There are various species of the wild Plum in the West Indies, some of them timber trees of large dimensions; but those most valued for their fruit are the sappodilla plum *(achras sapota)*, and the mammee sapota *(achras mammosa)*.

The Sappodilla Plum is a large and straight tree, which runs to a considerable height without any branches, with a dark gray bark, very much chapped. The leaves are smooth and beautiful, and the flowers white and bell-shaped. The fruit resembles a bergamot pear in shape and size, but in colour is like a medlar, and is similar also to that, in being eaten when it is beginning to decay.

The Mammee Sapota grows on a much smaller tree, with larger leaves, and flowers of a cream colour; the fruit about the same size as the former, but brownish when ripe, and containing a pulp resembling marmalade of quinces in consistency, and of a very delicious flavour. On account of this, the tree is sometimes called the marmalade tree, and is, in all probability, the same which Stedman, in his account of Surinam, calls the *marmalade box*. It is a native of the West Indies and the adjoining coast, and is very much cultivated in the gardens there for the sake of its fruit.

STAR APPLE *(chrysophyllum cainito)*. This is also a native of the West Indies. It grows on a moderately-sized spreading tree, with slender flexile branches. There are some species, or, at least, varieties of the fruit. The star apple, properly so called, bears fruit resembling a large apple, which, in the inside, is divided into ten cells, each containing a black seed, surrounded by a gelatinous pulp. The West Indian damson plum has small fruit, and is chiefly found in the woods. The milky juice of the star apple, both of the tree and the fruit, before it is ripe, is remarkably astringent; but when the fruit ripens, it is sweet and very agreeable to the taste.

GRENADILLAS *(passiflora)*. The passifloras are a very numerous race. They are mostly natives of the West Indies and the tropical parts of America, from which some of the species have been introduced into this country, chiefly on ac-

count of the beauty of their flowers. Few of the species bear fruit in this country.

The grenadillas with which we are best acquainted are those of the West India islands, the chief of which are the *purple-fruited (passiflora edulis)*, the *passiflora quadrangularis*, and the *water-lemon (passiflora laurifolia)*. The first is thus described by Sabine: "The stem is thick and woody, the leaves three-lobed, and of considerable size. The flowers, proceeding from the axilla of the leaves, are fragrant, and of a white colour, tinged with purple. The fruit, when unripe, is green; but as it ripens, changes to a dark livid purple, and much resembles the fruit of the purple egg plant. The shape is elliptic, an inch and a half in diameter, and two inches from the stalk to the top. The pulp is orange coloured, and the seeds numerous; the taste acid, and the flavour somewhat like that of the orange. It is a native of the Brazils, was introduced from Portugal, by Boehm, in 1810, and has produced fruit abundantly in the stoves at Walton on Thames, at the royal gardens at Windsor, and other places. Such is the rapid growth of this species, that a single plant will, in one season, extend in a line over upwards of forty feet of glass, in which space it will produce from 400 to 500 fruit.

The flesh-coloured grenadilla *(p. incarnata)* has a perennial root, sending up annually a number of herbaceous shoots, with threè-lobed leaves, and sweet scented flowers, variegated with purple, and appears from July to September. The fruit, when ripe, is about the size of an apple, orange coloured, with a Swedish yellow pulp. It is a native of Virginia, was cultivated in the open air, by Parkinson, in 1629, and afterwards by Miller, in the stove, with whom it bore fruit.

The *passiflora quadrangularis* is the most valuable for cultivation here; and it has borne fruit in the gardens of the Horticultural Society. The water lemon is a larger and more woody plant; the flowers are handsome and very fragrant; and the fruit something in the shape and of the size of a lemon, full of a watery but very agreeable tasted juice, whence the name. The plant grows wild in the woods, but is often cultivated for the sake of its fruit. It was introduced into England about the same time with the pine apple; but it has not met with equal attention.

On the American continent, and especially in Brazil, where the productions of the vegetable kingdom are very numerous and luxuriant, there are many varieties of grenadilla, if not distinct species, with which botanists do not appear to be very well acquainted; indeed, the forests and savannahs of Brazil appear to offer the richest harvest for botanical research of any places now on the surface of the globe. *Piso*, in his natural history of Brazil, enumerates and gives figures of several sorts of grenadilla, under the name of Murucuja. One, he says, has five-lobed leaves and purple flowers, with oblong fruit, larger than any European pear, filled with a mucilaginous pulp, of a scent and flavour that nothing can exceed. Another has the same leaf and flavour, but fruit in the form and size of an apple, the pulp of which has a vinous flavour. There are many other sorts, but these are described as the best. The grenadillas generally, which are called *parchas* by the Spaniards, have a pleasant sweetish acid, with a fragrance something between that of a melon and a strawberry.

CHAP. XXXVIII.

THE MELON, CUCUMBER, GOURDS, LOVE APPLE, EGG PLANT, &C.

The natural family *cucurbitaceæ* consists of large herbaceous plants, frequently with twining, climbing stems, and covered with short, very stiff hairs. The leaves are alternate, petiolate, and more or less lobed. The tendrils, which are simple or branched, arise beside the petioles. The flowers are generally unisexual, and monœcious, very rarely hermaphrodite. The fruit is fleshy, mostly sweet, watery, cooling, and pleasant to the taste; or bitter, drastic, and purgative in its qualities. The seeds, when the fruit is ripe, seem scattered in the midst of a filamentous or fleshy cellular tissue.

The principal genera of this family are: The cucumis, cucurbita, pepo, ecballium, memordica, bryonia, gronovia. Thus including several esteemed and cooling fruits, as the melon, gourds, cucumber; as also the colocynth and bryons, both drastic purgatives. The papaw tree, classed among this family, is a remarkable deviation from the ordinary herbaceous and climbing character which distinguishes the others.

The Melon, *(cucumis melo.) Monœcia monandria* of Linn.

The melon is the richest and most highly flavoured of all the fleshy fruits. It is often said to be a native of the central parts of Asia, and to have been first brought into Europe from Persia; but the date of its first culture is so remote, that there is no certain knowledge on the subject. Pliny and Columella describe the fondness of the Emperor Tiberius for melons, and detail the contrivances by which they were procured for him at all seasons. Stoves appear to have been used in this process; so that forcing-houses were not unknown to the Romans. The melon has certainly been generally cultivated in England since about the middle of the sixteenth century; how much earlier is not known. It is

highly probable that those ecclesiastics who paid such attention to the other fruits grown in Italy and France, would not neglect one so delicious as the melon; and it is distinctly said by a writer on British Topography, Gough, that the cultivation of the melon in England preceded the wars of York and Lancaster, but that it was destroyed in the times of civil trouble that succeeded. It is probable, however, that the melon was confounded with the pumpkin by the earlier writers whom Gough consulted. While in France, and in England, melons are grown as an article of luxury, in some parts of the East they are used as a chief necessary of life. Niebuhr, the celebrated traveller, says, "of pumpkins and melons, several sorts grow naturally in the woods, and serve for feeding camels; but the proper melons are planted in the fields, where a great variety of them is to be found, and in such abundance, that the Arabians of all ranks use them, for some part of the year, as their principal article of food. They afford a very agreeable liquor. When its fruit is nearly ripe, a hole is pierced into the pulp; this hole is then stopped with wax, and the melon left upon the stalk. Within a few days the pulp is, in consequence of this process, converted into a delicious liquor."

Although the melon is a very delicious fruit, it is not one of the most wholesome, more especially in cold climates, where, if eaten in any considerable quantity, it is apt to derange the stomach, unless corrected by warm and stimulating ingredients; and the same remark may be applied to the cucumber.

Small melons are, when equally ripe, more highly flavoured than large ones. In general, however, the fruit is chosen as much for show as for use, and thus the large ones are preferred. Indeed, in almost all the cultivated fruits and vegetables, quality is very apt to be sacrificed to appearance; as in the markets the articles are bought by the judgment of the eye, and not by that of the palate. To obtain the large size, a ranker manuring and higher culture must be resorted to than are altogether consistent with the natural development of the juices of the plant.

Of the melon there are many varieties, and the number of them is constantly increasing. Seventy-one are enumerated in the Fruit Catalogue of the Horticultural Society. The Cantaloupe is one of the best. It obtains its name from a seat belonging to the Pope, not far from Rome, where it was probably first cultivated in Europe, and whence it has spread into most countries. The Cantaloupe is of a middling size, nearly round in form, and remarkably rough and irregular in the surface. The colours, both of the surface and the flesh, vary; the former from orange mottled with green, to green mottled with black; and the latter from white, or nearly so, to orange tinged with rose colour. The flesh of some varieties is greenish; but these are inferior to the others. When melons of this sort are equally ripened, it may be considered as a general rule, that those which are darkest on the outside, most richly tinted in the flesh, and of a moderate size, have the most high and musky flavour.

There is also a small African or Egyptian melon, the flesh of which is green, of a particular excellence. Frederick the Great was passionately fond of these melons; and Zimmerman, who attended him in his last illness, finding him very ill from indigestion, discovered that he ate three or four of them daily for breakfast. On remonstrating with the king, the only answer that the physician could get was, that the king would send him some of the fruit to taste the next day, as if its excellence would be a sufficient apology for the habitual indiscretion.

The Romana is also a fine lemon; and it ripens earlier than the Cantaloupe. The surface is often netted. It is of an oval shape, highly flavoured, and when good, very heavy and solid.

The Salonica, which has been but recently introduced into this country, is a beautiful melon. It is spherical, smooth, and of a fine golden colour. The flesh is white, very sweet, and in consistency resembling the water melon. The Salonica preserves its qualities, though it is very large; and with good culture specimens may be had weighing seven or eight pounds.

The small Portugal is a very early and productive melon, but not remarkable for flavour. The rock melons are thickly set with knobs; they are of various colours, and some of them of very fine flavour. The oblong-ribbed is marked into segments from the root to the crown; it is very productive; and the flavour is so high, that it is sometimes called, by way of eminence, the musk melon.

The melon in this climate, to be raised to perfection, requires the aid of artificial heat and glass throughout every stage of its culture. Its minimum temperature may be estimated at 65°, in which it will germinate and grow; but it requires a heat of from 75° to 80° to ripen its fruit, which, in ordinary cases, it does in four months from the time of sowing the seeds. A rich mould of vegetable extract, with sand, is the most suitable soil.

The melons of Persia have long borne a high character. "Persia," says Malte Brun, writing after Chardin, Oliver, and Langles, "is consoled for the occasional failure of her grain crop, by the fineness of her fruits. There are twenty sorts of melons, the finest in Khorassan. In Persia, this fruit is extremely succulent, and contributes greatly to health. They are sometimes so large, that three or four are a full load for a man." It was not till lately that the seeds

of melons were received here direct from that country. In 1824, Mr Willock, the Ambassador to the Court of Persia, sent a parcel of seed, and another parcel in the spring of 1826. An account of ten varieties of these melons, by Mr Lindley, was read before the Horticultural Society in September, 1826; and the individual fruits referred to were the produce of the Society's garden that season.

The Persian melons are extremely rich and sweet; and instead of the thick rind of the common melons, they have a very thin and delicate skin, which makes a fruit of the same apparent size contain nearly twice as much edible matter. In addition to this, the melons are beautiful, and they bear abundantly; but they require a great deal of care. In the warm climate of Persia, the only attention which they ask from the cultivator is to be regularly watered; and though the melons may be supplied with water artificially, the air, in their native country, is still very dry: this humid soil and dry atmosphere are, as Mr Lindley remarks, very difficult to be obtained in this country. The covering which is requisite for confining the heat, confines also the moisture raised by evaporation. It is further judiciously observed in this paper, that the supply of water should be at the roots, and not over the plant; and that the air should be kept warm by repeated changes of soil on the surface, and dry by abundant ventillation. Some of the melons, of which Mr Willock furnished the seed, are ready for the table as soon as cut; and some are winter melons, which must be kept for some months before they are eaten.

The Cucumber, *(cucumis sativa.)* The cucumber is an annual plant, a native of the East Indies; and was introduced into this country about the year 1573. In England it is cultivated generally and extensively in forcing frames, and in the open air, and in great quantities near large cities. In Hertfordshire, whole fields are annually seen covered with cucumbers, without the aid of dung or glass; and the produce is sent to London for pickling. In March cucumbers are sold in the London market for a guinea a dozen; in August and September they may be bought for a penny per dozen. The village of Sandy, in Bedfordshire, has been known to furnish 10,000 bushels of pickling cucumbers in one week.

In the East the cucumber has been very extensively cultivated from the earliest periods, as well as most of the other species of gourd. When the Israelites complained to Moses in the wilderness, comparing their old Egyptian luxuries with the manna upon which they were fed, they exclaimed, "We remember the fish which we did eat in Egypt freely,—the cucumbers and the melons." Hasselquist, in his Travels, states that these cooling fruits still form a great part of the food of the lower class of the people in Egypt, especially during the summer months; and that the water melon in particular, which is cultivated in the alluvial soil left by the inundation of the Nile, serves them for meat, drink, and physic. The cucumber of Syria was cultivated in large open fields, in which a hut was erected for the abode of the watchman, who guarded the fruit against foxes and jackals. These fields, doubtless, were far away from the habitations of men; for Isaiah, speaking of the desolation of Judah, says, "The daughter of Zion is left as a cottage in a vineyard, as a lodge in a garden of cucumbers." In India, beyond the Ganges, bishop Heber saw a man in a small shed of bamboos and thatch, watching a field of cucumbers; and he was naturally interested in the circumstance, as being the same custom to which Isaiah alludes. He again observed a watcher of cucumbers, who lighted a fire during the night, to keep off the wild dogs and wolves from his fruit. On the west side of the Jordan, Burckhadt saw fields of cucumbers.

The cucumber has been known in England from the very earliest records of horticulture. Gough says, that it was common, like the melon, in the time of Edward III; but being neglected and disused, became entirely forgotten, till the reign of Henry VIII. It was not generally cultivated till about the middle of the seventeenth century. There are many varieties of cucumbers.

Some cucumbers are cultivated for their fantastic shapes, of which the *snake* is remarkable for its great length and small diameter; but it is of no value, except for show.

For raising cucumbers in the open air, a warm border is chosen exposed to the sun. Dig up the soft mould, and sow the seeds in the beginning of June; and when the plants come up train the shoots, and water them in dry weather in the morning or evening, keeping the soil always moist. The fruit will be ready in the end of July or in August.

Though cucumbers are thus extensively used, they are not esteemed a very safe article of food by our dieticians. The late Mr Abernethy gave a quaint receipt for their use, which was to peel off the cucumber, slice it, pepper it, put vinegar to it, and then throw it out at the window.

Gourds, *(cucurbita.)* Of the gourd there are many varieties, some of them of beautiful form and colour, and others of an immense size. In England, however, they are cultivated more as matters of curiosity than for food. One sort, the *pumpkin (cucurbita pepo,)* is occasionally eaten, but always in a baked state, and combined with other substances of higher flavour. In warm situations, and when highly manured, it grows luxuriantly in the open air; and villagers sometimes grow it, and, when ripe, convert it into a sort of pie, by cutting a hole in the side,

extracting the seeds and filaments, stuffing the cavity with apples and spices, and baking the whole. The pumpkin seems to have been earlier introduced into general culture than either the cucumber or the melon: the pumpkin is, in fact, the melon of the old English writers, the true melon being then styled the musk melon. The pumpkin or gourd enters more into the cookery of the southern nations on the continent, than into those of Britain.

The *squash, (cucurbita melopepo,)* has a large fruit, reddish, yellow, or yellowish-white, within and without; of a round form, but often flattened at top and bottom: occasionally warted. It is cultivated in America as an article of food.

The *water melon, (cucurbita citrullus.)* This is readily distinguished from all the other species, by its deeply cut leaves. The fruit is roundish, large, smooth; often a foot and a half in length, with a white icy flesh, streaked with dark red and black seeds. It is much cultivated in the warm countries of Europe, and also in Asia, Africa, and America, for its cooling quality. It is said to be a native of the Levant, but it is probably indigenous to many other countries. Hasselquist says, "the Arabians call it *batech*. It is cultivated on the banks of the Nile, in the rich clayey earth which subsides during the inundation, from the beginning of May until the overflowing of the Nile, towards the end of July or beginning of August; and in the island Delta, especially at Burlos, from whence the largest and best are procured. This fruit serves the Egyptians for meat, drink, and physic. It is eaten in abundance during the season, even by the richer sort of people; but the common people, on whom Providence hath bestowed nothing but poverty and patience, scarcely eat any thing but these during their season, and are obliged to put up with worse fare at other times. They eat them with a little bread, and scarcely ever taste them in their ripe state. The juice also serves them for a refreshing drink; for this purpose they make a hole in the melon, whence all the juice collects. A variety of a softer and more juicy nature also supplies them with physic, but this kind is more rare; it also comes from Burlos. When it is very ripe, almost approaching to putridity, the hollow part of it collects the juice, and mixing it with a little sugar and rose-water, they administer it in burning fevers, being the only medicine which the common people use in those maladies."

By Europeans this fruit should be eaten with great caution, especially during the heat of the day, and after exercise. Instances of sudden death have followed the eating of this fruit in any quantity. It is said also to favour the production of intestinal worms in those who live much on it.

The orange fruited gourd, (*cucurbita aurantia*) is a native of the East Indies. It is a very some variety, but cultivated only as a curi[illegible] The calabash or bottle gourd, *(cucurbita la[illegible]aria,)* is similar to the other in quality, and gets its trivial name as well from its form as from the use to which the hard and tough rind is applied. It is a native both of the East and the West Indies; and the humbler inhabitants employ these gourds as ready made bowls and other vessels. In some parts of the East, gourds are sufficiently large to support a man in the water, who floats upon a cross bar fastened to the top of two of vast dimensions. The Arabians call the bottle gourd *charrah*. The poor people eat it boiled with vinegar, or fill the shell with rice and meat, and thus make a kind of pudding of it.

Vegetable marrow (cucurbita succada,) is a very important gourd; and though it has been but lately introduced into this country, it is already cultivated to a considerable extent. It is straw coloured, of an oval or elongated shape, and when full grown attains the length of about nine inches. When very young, it eats well, fried in butter; when half grown, it may be cooked in a variety of ways, and is peculiarly soft and rich, having an oily and almost an animal flavour; when fully matured, it may be made into pies, for which purpose it is much superior to any of the other gourds. But it is in the intermediate or half grown state only, that it deserves its common appellation of vegetable marrow. The vegetable marrow gourd is a native of Persia; but if the soil on which it is placed be rich and warm enough, it thrives very well with us in the open air.

"I have been able," says Mr Sabine, "to obtain but very imperfect accounts of the origin of this gourd. It was certainly new in this country within a few years; and I think the most probable account, of the many that I have heard, of its introduction, is, that the first seeds were brought here in one of our East India ships, and came probably from Persia, where, as I am told, it is known, and called cicader. Its cultivation is easy." If any other kind of gourd grow in the neighbourhood, no reliance can be placed on the goodness of the seed of the vegetable marrow.

The Papaw, *(carica papaya.)* Though the papaw tree is now found in the East as well as in the West, it is generally understood to be a native of America, and to have been carried to the East about the time of the first intercourse between the two continents. The papaw rises with a hollow stem to the height of about twenty feet, after which it has a head composed, not of branches, but of leaves and very long foot-stalks. The male and female flowers are on different trees: the female flowers are bell-shaped, large, generally yellow, and followed by a fleshy fruit, about the size of a small melon. The tree, and

even the fruit, are full of an acrid milky juice; but the fruit is eaten with sugar and pepper, like melon; and when the half grown fruit is properly pickled, it is but little inferior to the pickled mango of the East Indies. There are many forms in the fruit, and some varieties in the colour of the flower of the papaw: and there is also a dwarf species; though, as this has been observed chiefly in arid situations, it may be the common sort stunted for want of moisture.

Love Apple, *(solanum lycopersicum.)* The natural family *solaneæ,* contains plants for the most part of a narcotic and poisonous quality, as the deadly nightshade, henbane, strammonium, tobacco, and several others. It also contains a species whose roots are edible, the potato already described, and the following edible fruits.

142.

Egg Plant.

The love apple, or tomata, is a native of the tropical parts of South America; but as it now thrives well in the warmer countries of Europe, and will, if the plants are forwarded in a hot-bed in the early part of the season, produce fruit with as much certainty in this country, upon a warm border, it may be considered as naturalized in the temperate regions. It is an annual: the leaves and flowers have some resemblance to those of the potato, only the latter are yellow. The fruit, when ripe, attains the size of a small apple. It is compressed at the crown and base, and furrowed along the sides; the whole is of uniform colour, and smooth and shining. There are some varieties both in the shape and colour of the fruit; bright red and orange are the prevailing colours. The love apple is used for eating in every stage of its growth. When green, it is pickled or preserved; when ripe, it is employed for soups and sauces, and the juice is made into a kind of ketchup. In this country, however, where the culture requires a good deal of care, except in favourable situations, the love apple is not in very general use; but in warmer countries it is in much more esteem, so that in Italy, whole fields are covered with it, and it is a general article at table.

Humboldt describes a species of the *solanum,* which he conceives indigenous to the isle of Cura, and which is at present cultivated in many parts of South America. The fruit is round and small, but very savoury.

The *egg plant* belongs to the same family, has the same habits, and requires nearly the same culture as the love-apple. It is found in the warmer parts of Africa, Asia, and America: it is an annual; rises to the height of about two feet; bears light violet flowers, which are followed by large fleshy berries, having the size and shape, and, in the white varieties, very much the colour and resemblance of eggs, whence the common name. The forms of the egg plant are globe-shaped and oval; and some of both forms are white, and others purple or mottled. The egg plant, according to the Hortus Kewensis, has been cultivated in England since the year 1596; but it has seldom been made use of as an article of cookery. Even on the continent, where the temperature agrees better with its habits, it has not so much flavour as the love apple; but still it is used in soups and stews, and is also eaten sliced and fried with oil or butter. Though the young plants require to be forwarded in a hot-bed, they may afterwards be made to produce fruit on warm and sheltered borders; and both they and the love apple succeed best when placed against a sunny wall.

Besides the white egg plant, (the *solanum melongena* of Linnæus,) which has been long cultivated as a curiosity, though never used as food, there are several others; and M. Dunal, in his History of Solanums, has separated the edible ones, of which he has enumerated four varieties, into the species of *solanum esculentum.* The round and the long variety of the esculent are both cultivated in the garden of the Horticultural Society. The plants, which are annuals, are raised to the height of nine or ten inches in the stove, and then planted on the borders in the open air, where they grow to the height of between two and three feet. The fruits of both are large: the round, or rather oval (for that is its proper shape, is four inches long, and about three thick. This variety is called the Mammoth egg plant. The long has larger fruit, measuring sometimes as much as eight inches in length. They vary much more in colour than the round, some of them being streaked with yellow. Other varieties are described as being found in India; but the seeds that have been sent to this country have produced fruit similar to the kinds now mentioned.

Various species of the solanum are common in the Levant: and three are particularly described by Dr Walsh in the Horticultural Transactions. The following is the substance of his communication:

Solanum Æthiopicum is the scarlet egg plant, of which the fruit is produced in the neighbourhood of Constantinople; but it is rare, being never sold in the markets, and but seldom seen

in private gardens. It is used as an ingredient in soups.

Solanum Sodomeum is a purple egg plant, of which the fruit is large and handsome. A species of *cynips* often attacks and punctures the rind; upon which the whole fruit gangrenes, and is converted into a substance like ashes, while the outside is fair and beautiful. It is found on the borders of the Dead sea, and is that apple, the external beauty and the internal deception of which have been so celebrated in fabulous, and so perplexing in true history.

> "Dead sea fruits, that tempt the eye,
> But turn to ashes on the lips."

The dreadful judgment of the cities of the plain, recorded in sacred history—the desolation around the Dead sea—the extreme saltness of its waters, the bitumen, and, as is reported, the smoke that sometimes issued from its surface—were all calculated for making it a fit locality for superstitious terrors; and among the rest were the celebrated apples which are mentioned by Josephus, the historian of the Jews, not as fabulous matters of which he had been told, but as real substances which he had seen with his own eyes. He says, they "have a fair colour, as if they were fit to be eaten; but if you pluck them with your hand, they vanish into smoke and ashes."

Milton, who collected all of history or fable that could heighten the effect of his poem, refers to those apples as adding new anguish to the fallen angels, after they had been transformed into serpents, upon satan's return from the temptation of man.

> ———————"There stood
> A grove hard by,
> — —— laden with fair fruit, like that
> Which grew in Paradise, the bait of Eve,
> Us'd by the Tempter: on that prospect strange
> Their earnest eyes they fix'd, imagining,
> For one forbidden tree, a multitude."
>
> * * * * *
>
> "They parched with scalding thirst, and hunger fierce,
> ——————— could not abstain;
> But on they rolled in heaps, and up the trees
> Climbing, sat thicker than the snaky locks
> That curl'd Megæra: Greedily they pluck'd
> The fruitage fair to sight, like that which grew
> Near that bituminous lake where Sodom placed;
> This more delusive, not the touch but taste
> Deceives; they fondly thinking to allay
> Their thirst with gust, instead of fruit
> Chew'd bitter ashes, which the offended taste
> With sputtering noise rejected."

Henry Teonge, a chaplain in the English fleet, whose Diary was, a few years since, published from the original manuscript, so well describes the real condition of the decayed *solanum sodomeum*, which he states that he saw in December, 1675, that no one can doubt that his notice was founded upon personal examination. "This country (that about the Dead sea) is altogether unfruitfull, says he, "being all over full of stones, which looke just like burnt syndurs. And on some *low shrubbs* there grow *small round things*, which are called apples, *but no witt like them*. They are somewhat fayre to look at; but touch them and they moulder all to black ashes, like soote, boath for looks and smell." Though these are only the remarks of a popular observer, who told what he saw, without any view to a scientific purpose, the single addition of the attack of the plant by the insect, and the subsequent mortification and internal drying, would have made it just as perfect as the descriptions of the present day.

Pocock, who travelled more than fifty years after Teonge, did not see the apples; and though he did mention them, he pointed to a plant very different from the real one: "As for the fruits of Sodom, fair without and full of ashes within," says he, "*I saw nothing of them;* but from the testimony we have, something of the kind has been produced. But I imagine they may be pomegranates, which, having a tough hard rind, and being left on the trees for two or three years, the inside may be dried to dust, and the outside remain firm." Mariti, who visited those regions thirty years after Pocock, mentions, that "No person could point out to me in the neighbourhood that species of fruit called the apples of Sodom, which, being fresh and of a beautiful colour in appearance, fall to dust as soon as they are touched." Hasselquist, however, not only found the apples, but the plant, referred it to the Linnæan species of *solanum melongena*, and pointed out the cause of the disease; and though, in the more recent and accurate division of the genus *solanum*, to which allusion has been made, the name of *Sodomeum* has been substituted for that of *melongena*, the fruit and the disease have been proved to be as Hasselquist stated.

Solanum melongena is more common in the markets of Constantinople than either of the former sorts, being almost as abundant as the gourd and the melon, and used for nearly the same purposes. There are several varieties of this solanum. The first appearance of the plant, it is said, is always attended with a north-east wind of some continuance; and, therefore, the ships for the Black sea sail before this harbinger, or rather companion, of bad weather comes forth. This is probably one of the superstitions which in all countries attach to matters so uncertain as the weather.

In this country the seeds must be sown in rich mould, and raised in a hot-bed, from about the vernal equinox till May. About the middle of the month they may be transplanted to a warm sunny border, where, if duly watered and tended, the fruit will be ripened in August.

CHAP. XXXIX.

THE WALNUT, CHESTNUT, HAZEL NUT, ACORN, CASHEW NUT, &c.

THE WALNUT *(juglans regia).* Nat. fam. *terebintaceæ; monœcia, polyandria,* of Linnæus. The fruit, or nut, of the walnut is a universal favourite; and "wine and walnuts" form, in the dessert, an association not likely to become extinct. The general objection against nuts applies, in some degree, to this variety; but it is more pleasant to the taste, and less injurious to the stomach, than many other kinds.

The Walnut.

The common walnut is a handsome and useful tree. The branches assume a graceful form; and the warm hue of the foliage in spring forms a pleasing contrast with other trees. The flowers begin to open about the middle of April, and are in full blow by the middle of May, before which time the leaves are fully displayed. It drops its leaves early in the autumn.

In the colder parts of Britain the fruit does not come to maturity; and even in the warmer, it is occasionally liable to be nipt by the spring frosts; but in most situations it flourishes as an ornamental and useful tree in gardens and shrubberies. The walnut is supposed to be a native of Persia and the south side of mount Caucasus, and is probably the Persian nut mentioned by Theophrastus. It is the *juglans*, or nut of Jove, of the Romans. It is found growing wild in the northern parts of Persia, sometimes, though more rarely, in the Russian territory to the north of the Caucasus, and in China. In the east of France, the south of Germany, and Switzerland, it is very abundant, more especially in Germany, in many parts of which, such as the plains of the Bergstrasse, which run parallel to the Rhine, between the Neckar and Mayn, there is hardly any other timber. It is supposed to have been introduced into England from France, and called *gaul*-nut, previous to 1562. Before the introduction of mahogany and other foreign woods, the walnut was much used in England in all sorts of cabinet work, for which the wood was well suited, being tough and strong in proportion to its weight, of a beautiful variegated texture, susceptible of a fine polish, of sufficient size, and very durable. In many parts of the continent this wood is still extensively used for domestic articles of furniture; and both there and in Britain for the manufacture of the stocks of all kinds of fire-arms. In England there are still a good many walnut trees scattered over the country, although the same attention is not paid to planting it, and thus affording a supply for the more limited and casual demand of the wood. This tree grows rapidly till it has attained a considerable size. Its duration is not well ascertained; but probably the most profitable period for cutting it down is when it has attained the age of fifty or sixty years.

The kernel, which is externally of a corrugated form, is contained within an oval-shaped shell, and this again is enveloped in a green husk. It is, when ripe, esteemed as a fruit; but from its containing a large proportion of oil, is like all substances of the kind, apt to disagree with many stomachs. The green fruit makes an agreeable pickle; and the expressed oil is somewhat similar to almonds, and is used as a finer sort by painters. It is also used in cooking, and for burning. The Spaniards strew the gratings of old and hard walnuts, first peeled, into their tarts and other meats. When the leaves and recent husks, in their green state, are macerated in warm water, the extract, which is bitter and astringent, is used to destroy insects; and it is a very permanent dye, imparting to wool, or the skin and nails of the living body, a dingy greenish yellow, which cannot be obliterated without a great deal of labour. On this account it is said to have been used by gypsies, in staining the complexions of stolen children, that they may appear to be their own offspring. The quantity of oil in fresh walnuts is very considerable, being about equal to half the weight of the kernels. A bitter decoction of the unripe fruit has been extolled as a cure for intestinal worms: Pliny thus recommends it; but it has now been superseded by other more certain and powerful remedies.

Of the common walnut there are several varieties; as the large, the thin shelled, the thick shelled, the late ripe, the double, and the French walnut. But the nuts from these respective varieties do not always produce fruit of their own kinds, so that no dependence can be put on the seeds until the tree has produced fruit.

Besides raising from seeds, the tree may be propagated, according to the method of Knight, by budding, or by layers and inarching. The tree will succeed in any fertile soil, as a light or clayey loam, provided the subsoil be dry, and the site a little sheltered; but it thrives best

where there is a good depth of loam, mixed with sand or gravel rather than clay. As this tree is long before it bears fruit, there is a particular inducement for procuring plants from the nursery either inarched, budded, or in as advanced a stage as it will be safe to remove them. This may be when they are from eight to twelve years old. A line of walnut trees serves as a good screen to an orchard of fruit trees—the plants should stand at 25, the trees at 50 feet distance. All those trees which are intended for timber only, should be sown in the places where they are to remain, in order to preserve the tap root, for when once broken, the tree ceases to aspire, but inclines to branch out. On the contrary, transplanting, by destroying the tap root, renders the tree more fruitful; it being a common observation, that downright roots greatly encourage the luxuriant growth of timber, and that such trees as spread their roots near the surface always produce the greatest quantity and best flavoured fruit. The best season for transplanting is as soon as the leaves begin to decay; and if they are carefully taken up, and their branches preserved entire, the success will be almost certain, even at the ages of eight or ten years.

Of the walnut there are the following species:

The Black Virginian Walnut (juglans nigra), with spear-shaped serrated small leaves, and the exterior ones smaller. This tree grows to a large size in North America. The leaves are composed of five or six pair of spear-shaped lobes, which end in acute points, and serrated on the edges. These leaves, when bruised, emit a strong aromatic flavour, as do also the outer covers of the nuts, which are rough and rounder than those of the common walnut. The shell of the nut is very hard and thick, and the kernel small, but very sweet. A variety of this species has heart spear-shaped leaves, and downy footstalks, with very long fruit, and kernel deeply furrowed.

Hickory (juglans alba). This tree is also very common in most parts of North America. The leaves are composed of two or three pair of oblong lobes, terminated by an odd one. They are of a light green colour, with serrated edges. The fruit is shaped like the common walnut; but the shell is smoother, and of a light colour. It is edible, and yields an oil similar to that of the walnut. One part of the wood is more porous than that of the walnut; but the other is more compact. This gives the grain of the wood something of the appearance of that of the ash, and it is used for similar purposes, the small shoots for hoops, and the grown trees for agricultural instruments. It is very tough and elastic, and suits well for the shafts and poles of wheel-carriages, fishing-rods, &c.

In favourable situations, this tree grows well in England. The trunk rises to a considerable height, of a nearly uniform thickness, as straight as a line, and without any lateral branches.

The Pennsylvania Walnut (juglans cinerea). This species seldom exceeds the height of thirty feet. The leaves are long, and composed of seven pairs of folioles, terminated by an odd one. The flowers are yellow, and come out at the same time with the others, and are succeeded by a small, roundish, hard-shelled fruit.

The Chestnut (*fagus castanea*). Nat. fam. *amentaceæ; monœcia, polyandria*, of Linnæus. The fruit, or nut, of the chestnut is much esteemed as an accompaniment to the dessert, and when roasted, is both nutritious and agreeable. This is a splendid tree, growing to a great size, and enduring for ages. The leaves are large, lanceolate, and deeply serrated on the edges.

141.

The Chestnut.

The male flowers are collected in long catkins, and begin to open about the month of May; the buds usually appear about the middle of April, and in a few days are followed by the leaves, which remain green till October, when they assume a yellow tinge. The fruit is contained within a strong skin, or leathery coat, and this again is surrounded with a second coat, covered with numerous spines or bristles. The chestnut is composed chiefly of farinaceous and mucilaginous matters. It is commonly eaten roasted, with a little salt, or it may be eaten raw. On the Continent it is not only boiled and roasted, but puddings, cakes, and bread, are made of it. According to Phillips, chestnuts stewed with cream make a favourite dish, and many prefer them as stuffings for Turkeys. They are also stewed and eaten with salt fish.

The chestnut tree is generally understood to be a native of Asia, in many parts of which it

is to be found in situations where it is not very likely to have been planted. Tradition says that it was brought from Asia Minor by the Emperor Tiberius, and that it soon spread all over the warmer parts of Europe. At present it is very abundant, as a native tree, in the mountainous parts of the south of Europe; and it is also found in North America, from New York to Carolina. The *castagno de cento cavalli*, or 'chestnut of the hundred horses,' upon Mount Etna, is probably the largest tree in Europe, being more than two hundred feet in circumference. Brydone, a traveller who wrote about fifty years ago, has given a particular description of this celebrated tree:

"From this place it is not less than five or six miles to the great chestnut trees, through forests growing out of the lava, in several places almost impassable. Of these trees there are many of an enormous size; but the *castagno de cento cavalli* is by much the most celebrated. I have even found it marked in an old map of Sicily, published near an hundred years ago; and in all the maps of Etna and its environs, it makes a very conspicuous figure. I own I was by no means struck with its appearance, as it does not seem to be one tree, but a bush of five large trees growing together. We complained to our guides of the imposition; when they unanimously assured us, that, by the universal tradition and even testimony of the country, all these were once united in one stem; that their grandfathers once remembered this, when it was looked upon as the glory of the forest, and visited from all quarters; that for many years past it had been reduced to the venerable ruin we beheld. We began to examine it with more attention, and found that there is an appearance that these five trees were really once united in one. The opening in the middle is at present prodigious; and it does, indeed, require faith to believe that so vast a space was once occupied by solid timber. But there is no appearance of bark on the inside of any of the stumps, nor on the sides that are opposite to one another. Mr Glover and I measured it separately, and brought it exactly to the same size, viz. two hundred and four feet round. If this was once united in one solid stem, it must with justice, indeed, have been looked upon as a very wonderful phenomenon in the vegetable world, and deservedly styled the glory of the forest. I have since been told by the Canonico Recupero, an ingenious ecclesiastic of this place, that he was at the expense of carrying up peasants with tools to dig round the *castagno de cento cavalli*, and he assures me, upon his honour, that he found all these stems united below ground in one root. I alleged that so extraordinary an object must have been celebrated by many of their writers; he told me that it had, and produced several examples.

In most parts of Britain the chestnut thrives well, there being authenticated anecdotes of many very large ones in various parts of England and Ireland. Nor is it confined to the southern parts of the islands, for there is one in the garden at Castle Leod, in Ross-shire, which measures at least fifteen feet in circumference, and which, only a few years ago, showed no signs of decay. Nor is it by any means a slow-growing tree; for in Kensington Gardens, and other places, where it has been planted along with elms and other trees of very inferior timber, it equals them both in height and diameter. If the symptoms of decay that are apparent in some of those trees, of which the age is known not much to exceed a hundred years, are to be taken as evidence of the general failure of the tree, and not of its being in a situation indifferently adapted for it, we should be led to question the great antiquity which has been assigned to some of the chestnut trees in England. The lives of trees must, however, like those of animals, vary with the situations in which they are placed; and the immense size of the celebrated chestnuts must lead us to assign to them a much longer duration than belongs to some others of the same species.

Though none of the English chestnuts rival the great one on Mount Etna, yet this country possesses immense trees. That at Hitchin Priory, in Hertfordshire, had, in 1789, a circumference of more than fourteen yards at five feet from the ground; and though the internal part was decayed and hollowed by time, the external part and the leaves were vigorous. Grose found one of four chestnuts in the garden at Great Cranford Park, Dorset, thirty-seven feet in circumference; and though shattered and decayed, it still bore good crops of fruit. In Gloucestershire there was a chestnut, in the hollow of which was "a pretty wainscoted room, enlightened with windows, and furnished with seats;" and the great chestnut at Tortworth, in the same county, had dimensions, and a reputed age, belonging to no other English tree. In the year 1150, it was styled the great old chestnut tree. In 1720, it measured fifty-one feet, at six feet from the ground; but Lysons, by a later mensuration, 1791, made it only forty-five feet three inches. It bore fruit abundantly in 1788; and tradition carries its origin back to the days of the Saxon Egbert.

The chestnut tree is very ornamental when growing, and it makes excellent timber. In extreme age, too, its timber is not so valuable as when of a moderate size. One advantage of chestnut is, that there is very little sap-wood; and thus, in the growing state, it contains much more timber of a durable quality than an oak of the same dimensions.

In the Transactions of the Society of Arts for 1789, there is an account of the comparative durability of oak and chestnut, when used for posts.

Posts of chestnut, and others of oak, had been put down at Wellington, in Somersetshire, previous to 1745. About 1763, when they had to undergo repair, the oak posts were found to be unserviceable, but the chestnut were very little worn. Accordingly, the oak ones were replaced by new, and the chestnut allowed to remain. In twenty-five years (1788) the chestnut posts, which had stood about twice as long as the oak, were found in much better condition than those. In 1772 a fence was made, partly of oak posts and rails, and partly of chestnut. The trees made use of were of the same age, and they were what may be termed young trees. In nineteen years the oak posts had so decayed at the surface as to need to be strengthened by spurs, while the chestnut ones required no such support. A gate-post of chestnut, on which the gate had swung fifty-two years, was found quite sound when taken up; and a barn, constructed of chestnut in 1743, was found sound in every part in 1792. It should seem, therefore, that young chestnut is superior to young oak, for all manner of wood work that has to be partly in the ground. We have not heard of any case in which it has been tried against larch.

Chestnut trees of full growth were more abundant in England than they are now; the timber was used indiscriminately with oak, in the construction of houses, in mill-work, and in household furniture. Many plantations of it have been formed since the proprietors of land began to turn their wastes to profit, in the production of trees. It makes also excellent underwood, and is quick growing.

The fruit of the chestnut in England is inferior to the produce of the trees of the south of France and of Spain. In some provinces of France, and in Corsica, this fruit constitutes the principal food of the poorer people. The inhabitants of Limousin, a province of France covered with chestnut trees, have from time immemorial prepared them in a peculiar manner, which deprives them of all their astringent and bitter properties, and, thus prepared, they make them into bread.

The chestnut is the tree with which Salvator Rosa delighted to adorn his bold and rugged landscapes. It flourished in the mountains of Calabria, which furnished the scenes of many of this great artist's pictures. It grows not unlike the ash, except that its branches are more straggling.

There are numerous varieties of the chestnut, especially in the south of France and in Italy. In Devonshire there are some kinds which ripen their fruit somewhat earlier than the others.

The usual mode of propagating this tree is from well selected nuts; but if a fruit-bearing tree is the object, the Devonshire practice of grafting is preferable. The trees prefer a sandy loam, with a dry bottom; but will grow in any common soil, provided the subsoil be dry. The nuts ripen from the end of September to the end of October. When the outer capsule, containing the nuts, begins to divide, and the nuts appear of a brown colour, their full maturity is indicated.

The Hazel Nut, or Filbert, *(corylus avellena.)* Natural family *amentaceæ*. *Monœcia polyandria* of Linn.

This is a middle sized tree, with ovate, deeply serrated leaves. The male catkins make their appearance in September, on the previous year's shoots, but are not fully developed or expanded until the succeeding season, when the female flowers appear about the first of February, and in April are in full blow. These are small, and of a beautiful red colour. It is said that the hazel was originally imported into Italy from Pontus; and hence was known among the Romans by the name of *nux Pontica*, which, in process of time, was changed into that of *nux Avellana*, from Avellino, a city of the kingdom of Naples, where they were first cultivated; and, according to Swinbourne, where they are still reared to a great extent, producing an annual profit of nearly twelve thousand pounds.

The common hazel is found growing in a wild state in many woods and coppices in Great Britain. The nuts are extensively used as an article of food; and the wood is employed for hoops, fishing rods, walking sticks, crate making, and other purposes. Formerly the roots were used by cabinet makers; and where yeast was not always readily to be procured, the twisted twigs of the hazel were steeped in ale during its fermentation until they had imbibed a quantity of yeast, when they were hung up to dry; and in this way preserved this useful commodity for many months. The dry twigs thus saturated were immersed into new wort to promote its fermentation.

There are many varieties of the hazel nut, distinguished by the size and shape, as also by the quality of the kernel. The oblong large Spanish nut is most esteemed, and in general use.

The *Filbert* is not a distinct species, but merely a variety of the common nut.

The word filbert is a corruption of the original English name for this nut, *full-beard*, which was applied to the large and fringed husk, to distinguish it from the closer covering of the common hazel. Our old poet, Gower, assigns a more classical origin to the name:

> "Phillis
> Was shape into a nutte-tree,
> That all men it might see;
> And after Phillis, *Philberd*
> This tree was cleped."

Of the filbert there are many sorts. The red, white,

frizzled, and cosford, being esteemed the best. The cob nut is also a useful kind, because it fills and keeps well, and may suit some situations from its branches growing more upright than the other varieties. For large sized fruit the great cob nut, the Dowton large square nut, and the Spanish nut, may be selected.

The American hazel nut, *corylus Americana*, is also of a very excellent quality. Upwards of a hundred thousand bushels of foreign nuts are annually consumed in this country.

The Spanish nuts of the shops are fresh nuts from Spain; the Barcelona nuts are another variety, kiln-dried before exportation.

The *Constantinople nut (corylus colurna)* is a superior nut to even the best variety of the hazel. Its flavour is equal, and its size more than double. It is a round nut, invested with a deep calyx, or involucre, which covers it almost entirely, and is very much lobed and fringed at its extremity.

L'Ecluse, a distinguished gardener, brought the nuts of the *corylus colurna* from Constantinople, in 1582; and Linnæus states, that in the Botanical Garden at Leyden there was growing, in 1736, a fine tree of this species, planted by L'Ecluse. It was cultivated in England by Ray, in 1666. This tree grows naturally in the neighbourhood of Constantinople.

The natural soil of the hazel is a cool, dry gravelly and sandy loam, and this is the best for their cultivated state also. Filbert trees are generally planted in the orchard or in the slips which surround the kitchen garden. They require dressing every year, and a supply of manure. All the sorts can be propagated by grafting, layers, suckers, and seeds. To preserve the varieties distinct, the best mode of propagating is by grafting in February or March upon seedling or sucker stocks of the filbert or hazel. All the kinds bear principally upon the sides and ends of the upper young branches, and from small shoots which proceed from the bases of side branches cut off the preceding year.

A particular form of tree receives in some parts of the country, (especially in Kent, where the culture of the filbert is carried on with advantage) the name of the dwarf productive nut, though that name indicates rather the mode in which the tree is trained than the variety to which it belongs. Generally speaking, the filbert is but a low grower; but still considerable ingenuity is exerted in keeping it down, it having been found by general experience that the dwarfing of fruit trees is the most effectual means of ensuring a large and uniform crop, and fruit of superior quality. The trees that are dwarfed are not allowed to exceed seven feet in height; and they are trimmed in the form of a goblet, with an open centre, as is generally done with well managed gooseberry trees. When the tree comes into proper bearing, this goblet has attained a diameter of about six feet, which is every season covered with filberts, both outside and inside. The nuts are of excellent quality; and it is found by comparison, that a tree treated in this manner, with the ground regularly hoed and cleaned, will produce more than those which are planted in a hedge-row or coppice, and allowed to run wild in the usual manner.

The Rev. G. Swayne, having had a plantation of filberts, which for the twenty years of their existence had produced very little fruit, began to suspect a want of male blossoms. He therefore selected a number of catkins from the common hazel, and suspended them over the scarlet blossom of his filberts, and the result was, that the first year he had more fruit than he had during the twenty preceding ones. To prove that this was owing to the farina of the male blossoms, he tried some with and some without their assistance, and found the fruit produced only where the male blossoms had been applied. He taught this mode to a neighbouring farmer's wife who had a row of barren trees, and she was much delighted to find the plan succeed with these also; and next season sent her instructor 6 lbs. of very fine filberts from four old stunted trees that had not borne one for many years.

The maturity of the fruit is indicated by the crop turning brown, and by the nuts, which have also become brown, readily quitting the husk. If covered with dry sand, filberts will keep for several months without shrinking. By inclosing them in casks perfectly air tight, and placing them in a cool place, they may also be preserved for a year or more.

In a rude state of society wild nuts are supposed to have afforded a considerable portion of the food of man. Even acorns, or the rougher nut of the oak, are said to have been eaten by the ancient Britons. Beech mast or nuts are now used as well as acorns, as an excellent food for fattening pigs.

The Carob Tree, *(ceratonia siliqua.)* Natural family, *leguminosæ*. *Polygamia diœcia* of Linn.

This tree grows extensively in the south of Europe, particularly in some provinces of Spain, of which Valencia is the principal, and bears a fruit called the *carob bean*, which is an important article of commerce. It is chiefly used for the feeding of cattle; but furnishes a nutritive aliment to the poor in times when there is a scarcity of bread-corn.

This is generally considered the locust tree of scripture; and in Spain, where the seeds are eaten, it is called St John's bread. Ignorance of eastern manners and natural history, professor Martin observes, induced some persons to fancy that the locusts on which John the Baptist fed were the tender shoots of plants, and that the wild honey was the pulp of the pod of the carob, whence it had the name of St John's bread. There is

better reason to suppose, he adds, that the shells of the carob pod might be the husks which the prodigal son desired to partake of with the swine. The tree is very common in the south of Spain; and the seeds or beans, as they were then called, often formed the principal food of the British cavalry horses, during the war of 1811 and 1812. In our greeen-houses the plant seldom flowers.

Cashew Nut, *(annacardium occidentale.)* Natural family, *terebintaceæ. Enneand. Monogynia* of Linn.

This is an elegant tree, a native of Jamaica, bearing panicled corymbs of sweet-smelling flowers, succeeded by an edible fruit of the apple kind, of a yellow or red colour. The fruit has an agreeable subacid flavour, with some degree of astringency. The juice expressed and fermented yields a pleasant wine, and distilled, a spirit is drawn from it far exceeding arrack or rum. The dried and broken kernels are occasionally imported for mixing with old Madeira wine, the flavour of which they greatly improve.

145.

Cashew Nut.

The nut protrudes from one end of the apple. It is of the size and shape of a hare's kidney, but is much larger at the end next the fruit than at the other. The outer shell is of an ash colour, and very smooth; under this is another which covers the kernel; between these there is a thick inflammable oil, which is very caustic: this will raise blisters on the skin, and has often been very troublesome to those who have incautiously put the nuts into their mouths to break the shell. This oil has been used with great success in eating off ring worms, cancerous ulcers, and corns; but it ought to be applied with caution. The kernel when fresh, has a most delicious taste, and abounds with a sweet milky juice, and forms an ingredient in puddings, &c. When older it is generally roasted, and in this state is not so proper for weak stomachs. Ground with cacao it makes an excellent chocolate.

A milky juice exudes from the trunk of the tree by tapping, which stains linen a deep and indelible black. A semi-transparent gum is also produced from this tree, similar to gum Arabic.

The Juvia, *(bertholletia excelsa.)* This is one of the most extraordinary fruits of South America, which has been made familiar to us principally by the interesting description of Humboldt. It was first noticed in a geographical work published in 1633, by Laet, who says that the weight of this fruit is so enormous, that, at the period when it falls, the savages dare not enter the forests without covering their heads and shoulders with a strong buckler of wood. The natives of Esmerelda still describe the danger which they run, when the fruit falls from a height of fifty or sixty feet. The triangular grains which the shell of the juvia incloses, are known in commerce under the name of Brazil nuts; and it has been erroneously thought that they grow upon the tree in the form in which they are imported.

The tree which produces the juvia is only about two or three feet in diameter, but it reaches a height of a hundred and twenty feet. The fruit is as large as a child's head. Humboldt justly observes that nothing can give a more forcible idea of the power of vegetable life in the equinoctial zone than these enormous ligneous pericarps. In fifty or sixty days a shell is formed half an inch in thickness, which it is difficult to open with the sharpest instrument. The grains which this shell contains have two distinct envelopes. Four or five, and sometimes as many as eight, of these grains are attached to a central membrane. The Capuchin apes *(Simia chiroptes)* are exceedingly fond of the almonds of the juvia; and the noise of the falling fruit excites their appetites in the highest degree. The natives say that these animals unite their strength to break the pericarp with a stone, and thus to obtain the coveted nuts. Humboldt doubts this; but he thinks that some of the order of *rodentia*, such as the *cavia aguti*, are able to open the outer shell with their sharp teeth applied with unwearied pertinacity. When the triangular nuts are spread on the ground, all the animals of the forest surround them, and dispute their possession. The Indians, who collect these nuts, say "it is the feast of the animals, as well as of ourselves;" but they are angry with their rivalry. The gathering of the juvia is celebrated with rejoicings, like the vintage of Europe.

The Pistacia Nut, *(pistacea officinalis.)* The pistacia tree belongs to the natural family *terebintaceæ. Diœcia pentandria* of Linn. It is from twenty-five to thirty feet in height, with heavy tortuous branches, covered with a thick grayish bark. The leaves are large, oblong, and of a coriaceous texture. The male flowers are minute and scarcely visible, and spring from the sides of the branches in loose clusters: the female or fertile flowers are also small, and both are of a greenish colour. The fruit is a thin shelled, oval, acuminate nut, about the size of an olive. These nuts are produced in bunches, and are commonly in profusion. They are esteemed by some of a more agreeable flavour than the hazel nut or almond, and are annually exported to those parts of Europe where the tree does not flourish.

This tree is indigenous to Asia Minor, and is particularly abundant in Syria. It is cultivated to a considerable extent in Sicily, for the sake of its nuts. It succeeds in dry, stony, calcareous grounds, but thrives in a sandy or moist soil. In

forming plantations, care must be taken to select trees of different sexes, without which the fructification is impossible: one male should be allotted to five or six females; and to avoid mistakes, young grafted stocks should be procured, or suckers from the foot of an old tree. The male flowers are produced first; and some gardeners pluck them whilst yet shut, dry them, and afterwards sprinkle the pollen over the female tree; but the method usually followed in Sicily, where the trees are far asunder, is to wait till the female buds are open, and then to gather bunches of male blossoms ready to blow; these are stuck into a pot of moist mould, and hung upon the female tree till they are quite dry and empty. The operation is called *tonchearare*, and never fails to produce fructification. Sometimes the gardeners ingraft the male bud upon the female tree. The wood is hard, resinous, excellent for fuel, and proper for economical purposes.

According to Pliny, pistacio nuts were first brought to Rome about the reign of Tiberius by Vitellus, governor of Syria, and probably the tree was introduced into Italy at the same period. It has been long cultivated in Spain, Portugal, and the south of France; and when protected by a wall, and favoured by a southern exposure, it yields fruit even at Paris. It is less delicate than the orange tree, and thrives in the same soil and climate with the olive.

The Turpentine Tree, *(pistacia terebinthus,)* is another species of this genus. It yields a species of turpentine known as the Chios turpentine, which is of the consistence of honey; very tenacious, clear, and almost transparent; of a whitish yellow colour, and fragrant smell. It is procured by wounding the bark of the tree in several places about the month of July, when the turpentine ooses out, and is scraped off with a knife. Another species, *pistacia lentiscus*, produces the gum mastic.

CHAP. XL.

TEA, COFFEE, CACAO, HOPS, TOBACCO.

Besides those substances furnished by vegetables which constitute the food and nourishment of man, there are others which the refinements of civilization have added as luxuries, and which habit has at last rendered essential.

It is a singular enough circumstance that almost all these substances, although eagerly relished after the taste for them has been acquired by habit, are at first repulsive to the natural appetite; that they possess little or no nutritive qualities, and that they belong to that class of vegetable products called *narcotic*, which may be explained by stating that they produce a powerful influence on the nervous system; and that if taken in excess, especially before the system has been accustomed to their influence, that they are productive of deleterious effects on the living body.

Notwithstanding this, however, man in all his progressive stages has a strong craving for such stimulants. Even in the savage state, the bowls of intoxicating cava were as eagerly drained by the South sea islanders, as the infusion of tea by the more refined Chinese; and the mead and beer of the Scandinavians have only given place to the coffee and the fumes of tobacco of more modern times.

Tea, *(thea.)* Natural family *camelliæ*. *Monadelphia polyandria* of Linnæus.

146.

The Tea Plant.

This plant seems to have been known to and used extensively by the Chinese at a very ancient period; and although it is not yet two centuries since it was introduced into Britain, its use here is now almost universal; not less than 31,829,620 lbs. being consumed annually. Its importation employs a large capital, and numerous shipping; and so important is this article reckoned, that its fall or rise in price is looked upon with anxiety by the meanest individual in the nation. At its first introduction into Europe a great outcry was raised against it, and many ingenious and refined speculations were started regarding its insidious and deleterious effects on the human constitution. The origin, or at all events the exasperation of many diseases, was attributed to its influence; and many prospective evils were laid to its charge. Yet, since its introduction, men and women have lived, and multiplied, and died, much in the same way as before the leaf ever crossed the Chinese seas; and although its use in excess may often have been found deleterious in particular instances, yet its general effect on the health and habits of the community may rather perhaps be estimated as beneficial than the reverse.

It is not yet accurately ascertained whether there be more than one species of the tea plant,

or whether the different sorts of leaves are only from varieties of the same species.

The tea plant is a small evergreen shrub, much branched, and covered with a rough, dark, gray bark. The leaves and blossoms are not unlike the common hawthorn. The leaves are elliptical or lanceolate, entire, alternate, obtusely serrated, veined, and placed on short footstalks. The calyx is small, smooth, persistent, and divided into five obtuse segments. The flowers are white, often two or three together on separate peduncles, and placed at the axilla of the leaves. The corolla, in one sort, fig. *a*, has five petals; in another, fig. *b*, the petals are more numerous.

The filaments are very numerous, short, and inserted at the base of the corolla. The anthers are large and yellow, the germen roundish, or triangular. The style trifid, the capsule three-celled, containing three oblong brown seeds.

Linnæus describes two distinct species of the tea plant, founding the distinction on the numbers of the petals. Others have also observed that the leaves of tea plants differ considerably in shape and colour. De Loureird has described three species, the *cochin chinensis*, *cantonensis*, and *oleosa*. The first is a native of Cochin China, where it is extensively cultivated, and used as a beverage, and medicinally; the second is the *siaò chong chá* of the Chinese, or souchong of the Europeans; the third grows in the neighbourhood of Canton, where an oil obtained from its seed is used for many domestic purposes. Both the latter are brown, but more fragrant than the common green tea, which grows in the province of *To-Kien.* Notwithstanding that this author has described the three species of tea as above, he says, that on examining the dried flowers of the green tea brought from the province of Kiang Si, he observed a great diversity in the number of the parts of the calyx and corolla; hence, he concludes, that all the various teas are derived from the same botanical species, and that the different flavour and appearance of teas depend upon the nature of the soil, the culture, and the method of preparing the leaves. "This opinion," says Dr Woodville,* "which is founded on the sportive tendency of the flowers of the tea plant, clearly shows the fallacy of distinguishing the bohea and green tea trees by the number of their petals, which, even in this country, have been found to vary from three to nine; yet this circumstance by no means determines the botanical identity of the green and bohea teas; and while the present narrow and jealous policy of the Chinese continues, many interesting particulars respecting the natural history of tea must still remain unknown to Europeans.

Dr Abel could not satisfy himself whether there were two species or one; but is rather inclined to believe there are two, the *bohea*, fig. *a.* and *sasanqua*, *b.* Mr Main says that all the different sorts of tea are produced from the same kind or variety of the plant. All writers on the subject are agreed that the leaves of the true tea are adulterated by those of certain other plants. According to Mr Main, small proportions of leaves of other plants are sometimes added, but care is taken that it be not detected, as this is considered a deterioration. These are the leaves of the fragrant olive, *(olea fragrans;)* and sometimes those of the san-cha-yu, *(camelia sasanqua).*

In the sort called pekoe, small silvery leaves may be observed, which appear to be those of the *tokune*, *(azalea Indica)* all perfectly harmless. The Chinese, however, deny that any of the latter leaves are ever intermixed. Modern botanists have abolished the genus *thea*, and placed it under the *camelia* genus. It is curious that without any knowledge of the sexual system, the Chinese have done the same: *cha* or *tcha* is their name of tea, and *tcha fan* tea flower, that of camelia.

Perhaps the *bohea* may be taken as the only species, and the *viridis*, and others, as varieties. It is indeed doubtful, says Loudon, whether even the Chinese themselves know the original species, because the best varieties obtained from long experience and cultivation, are called by them the *true* white; the wild sort found on the mountains of Ho-nan, is called tchaw tcha, or bastard tea.

The tea plant is indigenous to China and Japan. The tea districts of China extend from the twenty-seventh to the thirty-first degree of north latitude. According to the missionaries, it thrives in the more northern provinces; and from Kampfer it appears to be cultivated in Japan, as far north as latitude 45°. It seems, according to Dr Abel's observation, to succeed best on the sides of mountains, where there can be but little accumulation of vegetable mould. The soils from which he collected the best specimens consisted chiefly of sandstone, schistus, or granite. The plants are raised from seeds, which are deposited in rows four or five feet apart.

The plant will grow in either low or elevated situations, but always thrives best and furnishes leaves of the finest quality when produced in light stony ground. The leaves are gathered from one to four times during the year, according to the age of the tree. Most commonly there are three periods of gathering; the first commences about the middle of April; the second at Midsummer; and the last is accomplished during August and September. The leaves that are earliest gathered are of the most delicate colour and most aromatic flavour, with the least portion of either fibre or bitterness. Leaves of the second gathering are of a dull green colour, and have less valuable qualities than the former; while

* Medical Botany.

those which are last collected are of a dark green, and possess an inferior value. The quality is farther influenced by the age of the wood on which the leaves are borne, and by the degree of exposure to which they have been accustomed; leaves from young wood, and those most exposed, being always the best.

The leaves, as soon as gathered, are put into wide shallow baskets, and placed in the air or wind, or sunshine, during some hours. They are then placed on a flat cast iron pan, over a stove heated with charcoal, from a half to three quarters of a pound of leaves being operated on at one time. These leaves are stirred quickly about with a kind of brush, and are then quickly swept off the pan into baskets. The next process is that of rolling, which is effected by carefully rubbing them between men's hands; after which they are again put, in larger quantities, on the pan, and subjected anew to heat, but at this time to a lower degree than at first, and just sufficient to dry them effectually without risk of scorching. This effected, the tea is placed on a table and carefully picked over, every unsightly or imperfectly dried leaf that is detected being removed from the rest, in order that the sample may present a more even and a better appearance when offered for sale. With some finer sorts of tea a different manipulation is employed; the heated plates are dispensed with, and the leaves are carefully rolled into balls, leaf by leaf, with the hands.

The names whereby some of the principal sorts of tea are known in China, are taken from the places in which they are produced, while others are distinguished according to the periods of their gathering, the manner employed in curing, or other extrinsic circumstances.

Bohea, of which description there are five kinds, takes its name from the mountain of Vou-yee, which is covered with tea plantations. The earliest gatherings, in this district, is called Souchong, the Chinese name for which is *Saatyang;* and *Pekoe*, called by the cultivators *back-ho*, or *pack-ho;* Congou, *Kongfou*, and other commoner kinds of Bohea tea, are made from the leaves when in a state of greater maturity. Padres Souchong, or *Pao-sut-tcha*, is gathered in the province where the best green tea is produced. This kind is esteemed on account of some medicinal virtues which it is supposed to possess.

There are three kinds of green tea, of which one called hyson, *(hayssuen,)* is composed of leaves very carefully picked, and dried with a less degree of heat than others: it is one-fourth dearer than souchong. The kind of green tea which is most abundant is called singlo, which is the name of a mountain on which it grows, about one hundred and fifty miles to the southward of Nan-king. Gunpowder tea is made of tender green leaves, which yet have attained a considerable size. This kind is sometimes rolled into balls by hand, and is very highly esteemed; it sells for fifteen per cent. more than hyson. It is a commonly received opinion, that the distinctive colour of green tea is imparted to it by sheets of copper, upon which it is dried. For this belief there is not, however, the smallest foundation in fact, since copper is never used for the purpose. Repeated experiments have been made to discover, by an unerring test, whether the leaves of green tea contain any impregnation of copper, but in no case has any trace of this metal been detected.

The succulent tea leaves are sometimes twisted into thin rolls or cords, about an inch and a half or two inches long, and several of these are tied together by their ends, with coloured silk threads. This is done with both green and black tea.

The Chinese do not use their tea until it is about a year old, considering that it is too actively narcotic when new. Tea is yet older when it is brought into consumption in England, as, in addition to the length of time occupied in its collection, and transport to this country, the East India Company were obliged by their charter to have always a supply sufficient for one year's consumption in their London warehouses; and this regulation, which enhanced the price to the consumer, is said to have been made by way of guarding, in some measure, against the inconvenience that would attend any interruption to a trade entirely dependent upon the caprice of an arbitrary government.

The people of China partake of tea at all their meals, and frequently at other times of the day. They drink the infusion prepared in the same manner as we employ, but they do not mix with it either sugar or milk. The working classes in that country are obliged to content themselves with a very weak infusion. Mr Anderson, in his narrative of Lord Macartney's embassy, relates that the natives in attendance never failed to beg the tea leaves remaining after the Europeans breakfasted, and with these, after submitting them again to boiling water, they made a beverage which they acknowledged was better than they could ordinarily obtain.

The tea plant is found in our conservatories, and in such situations has occasionally put forth blossoms in this country.

The tea plant, and its use as affording an agreeable and exhilarating beverage, must have been familiar to the Chinese from a very early period, and the following extract would show that even as an article of traffic with other nations, it was known so early as the first century of the Christian æra. In an ancient work entitled the *Periplous* of the *Erythræan sea*, the following passage occurs, "But there use to come yearly to the frontier of the Sinæ, a certain people called Sesatæ, with a short body, broad forehead, flat

noses, and of a wild aspect. They come with their wives and children, bearing large mats full of leaves, resembling those of the vine. When they have arrived on the frontier of the country of the Sinæ, they stop and spend a few days in festivity, using the mats for lying upon; they then return to the abode of their countrymen in the interior. The Sinæ next repair to the place and take up the articles which they left; and having drawn out the stalks and fibres, they nicely double the leaves, make them into a circular shape, and thrust into them the fibres of the seeds. Thus three kinds of *malabathrum* are formed; that from the larger leaf is called *hadrosphœrum*, that from the middling one *mesosphœrum*, and from the smaller *microsphœrum*." Although Vossius Vincent, and some other writers, have conjectured this description to refer to the betel nut, it appears much more likely to allude to tea.

Tea was first introduced into Europe by the Dutch East India Company; and about the year 1666, a small quantity was brought from Holland to England, by the lords Arlington and Ossory. At first it was sold for sixty shillings per lb.; and for many years its great price limited its use only to the most opulent.

According to the experiments of Dr Smith, as detailed by Cullen, a strong infusion of green tea has the effect of destroying the sensibility of the nerves, and the irritability of the muscles; and by distillation affords an odorous water, which is powerfully narcotic when long infused: the leaves also yield a bitter principle, which is tannin, known by its effects in forming a black precipitate with iron.

The recent plant is much more narcotic than that preserved dried for some time. Before tea leaves can be used with safety, they must be subjected to a considerable heat, and kept, as already stated, in the dry state for at least twelve months.

The tea manufacture has been prosecuted within these last three years in Assam, a recently acquired district to the north-east of Bengal, in our Indian possessions.

According to Mr Bruce, the superintendent's report, there are not less than 120 tea tracts among the mountains and plains. Some of them are of considerable extent; one near Jaipore, he mentions as being from two to three miles in length: the trees were in most parts as thick as they could grow, and the ripe seeds strewed the ground in abundance. One of the largest trees here was two cubits in circumference, and full forty cubits in height. The country around is populous, and grain plentiful and cheap; labour is easily procured, but the mass of the people are addicted to the pernicious and inervating use of opium, which is also raised in the district, and thus have less energy to exert themselves than could be desired. A few Chinese tea gatherers have been introduced into the country, and under their direction the manufacture of the various sorts of tea has been commenced.

Although, in China, the tea plant is said to thrive best on the sides of rather elevated hills, Mr Bruce thinks that in Assam the trees are most thriving in the valleys between the jungles, and on the banks of running streams. The tea shrubs are six feet and upwards in height; while in China they seldom exceed three feet. The Chinese tea gatherers pluck the leaves squatting on the ground; but the Hindoos find it a tedious and tiresome employment, as from the height of the trees they have to stand erect. By transplanting the trees, and denuding them of their leaves annually, Mr Bruce is of opinion that the Assam trees which have grown in a rich soil, and in a state of nature from time immemorial, may be gradually reduced to a more convenient height. Mr Bruce, in his report, alludes not to more than one species or even variety of the tea tree, the different kinds of tea being described as produced according to the time and manner of pulling the leaves, and of drying them.

The light of the sun is found to influence the colour of the leaf, turning it from a deep green to a yellow. The more the leaves are plucked the greater number of them are produced; thus successive crops are procured; but if the first set of leaves were not taken off, one might look in vain for the leaves of a second crop. The tea made from those leaves grown in the shade, is inferior to that from leaves exposed to the sun; the latter are also produced much earlier than the former. The leaves from the shady tract give out a more watery liquid when rolled, and those from the sunny a more glutinous substance. When the leaves of either are rolled on a sunny day, they emit less of this liquid than on a rainy day. This juice decreases as the season advances. The plants exposed freely to the sun produce flowers and seed much earlier than those in the shade, and in greater profusion. They blossom in July, and the seeds are ripe in November. Numerous plants are to be seen that by some accident, either cold or rain, have lost all their flowers, and commence throwing out fresh flower buds more abundantly than ever. Thus it is not unfrequent to see some plants in flower so late as March, bearing at once the old and the new seeds, flower buds, and full blown flowers, all at one and the same time. The rain also greatly affects the leaves, for some sorts of tea cannot be made in a rainy day. The leaves for *powchong* and *mingehew* ought to be collected in the morning of a sunny day, when the dew has evaporated. The *powchong* can only be manufactured from the leaves of the first crop; but the *mingehew*, although it requires the same care

in making as the other, can yet be made from any crop, provided it is made on a sunny morning. The Chinese dislike gathering leaves on a rainy day for any description of tea, and never will do so unless necessity requires it. The Assam season for tea making generally commences about the middle of March; the second crop in the middle of May; the third crop about the first of July; but the time varies according as the rains set in, sooner or later.

The mode of manufacturing the *sychee*, or black tea, is as follows. The leaves for this sort are what are termed the *souchong* and *powchong*. After they have been gathered and dried in the sun, they are beaten four different times; they are then put into baskets, pressed down, and a cloth put over them. When the leaves become of a brownish colour by the heat they throw out and have a peculiar smell, they are then ready for the pan, the bottom of which is made red hot. This pan is fixed in masonry, breast high, and in a sloping position, forming an angle of forty degrees. Thus the pan being placed on an inclined plane, the leaves when tossed about in it cannot escape behind or on the sides, as it is built high up, but fall out near the edge close to the manufacturer, and always into his hands, so as to be swept out easily. When the bottom of this pan has been made red hot by a wood fire, the operator puts a cloth to his mouth to prevent inhaling any of the hot vapour. A man on the left of him stands ready with a basket of prepared leaves; one or two men stand on his right with dollahs or shallow baskets, to receive the leaves from the pan; and another keeps lifting the hot leaves thrown out of the pan into the dollah, that they may quickly cool. At a given signal from the China man, the person with the basket of prepared leaves seizes a handful and dashes it as quick as thought into the red hot pan. The China man tosses and turns the crackling leaves in the pan for half a minute, then draws them all out by seizing a few leaves in each hand, using them by way of a brush, not one being left behind. They are all caught by the man with the dollah or basket, who, with his disengaged hand, continues lifting the leaves and letting them fall again, that they may quickly cool. Should a leaf be left behind in the pan by any accident, the cloth that is held ready in his mouth is applied to brush it out; but all this is done as quick as lightning. The man that holds the basket of leaves watches the process eagerly, for no sooner is the last leaf out of the pan than he dashes in another handful; so that to an observer at a little distance, it appears as if one man was dashing the leaves in and the other as fast dashing them out again, so quickly and dexterously is this managed. As soon as one basket has received about four handfuls of the hot leaves from the pan it is removed, and another basket placed to receive the leaves, and so on until all is finished. A good fire of wood is kept under the pan to keep the bottom red hot, as the succession of fresh leaves tends greatly to cool it.

The leaves are next rolled up and latched the same as other teas, and put into the drying basket for about ten minutes. When a little dry, people are employed to work and press them in their hands, in small quantities at a time, for about half a minute; they are then put into small square pieces of paper and rolled up; after this they are put into the drying basket, and permitted to dry slowly over a gentle fire for some hours, until the whole is thoroughly dry. This tea is not sold in the China market, but is used chiefly as offerings to the priests, or kept for high days and holidays.

The manufacture of green tea under the direction of Chinese labourers, at Assam, is as follows. All leaves, up to the size of what is called *souchong*, are taken for the green tea. About three pounds of the fresh leaves, or sometimes those that have lain gathered over night, are cast into a hot pan, and rolled, and tossed about until they become too hot for the hand, when they are further stirred by pieces of bamboo. They are then taken from the pan and rolled in dollahs, in a similar way as the black tea, for about three minutes. The leaves are then pressed hard between both hands until they assume a pyramidal form, and are then placed in open baskets exposed to the sun for a few minutes; these pyramids are then gently opened, and the leaves spread out to dry. The rolling up and spreading out is repeated three times in the open air if the weather be sunny and dry; if rainy, over a fire. After the third rolling and drying there is very little moisture remaining in the leaves. They are now turned into a hot pan, gently stirred and dried, and from this transferred to a strong bag, where they undergo great compression by the hands and feet of the operator. After remaining a night in this bag, the leaves are again emptied out, gently separated, and for the last time dried over the fire, till they become quite crisp. In this state the tea is placed in boxes or bamboo baskets, where it may remain for months, until it undergoes the second process, which is as follows. The boxes being opened, the tea is taken out and exposed in large shallow baskets, until it has become soft enough to roll. It is then put into cast iron pans, set in brick fire-places, the same as those used for the sychee black tea. The pan is made very hot, and about seven pounds of the leaves are thrown in at a time, and rubbed against the sides for a considerable time. The pan being placed on an inclined plane the leaves always come towards the operator, while he pushes them from him again, moving his hand backwards and forwards, and pressing on the leaves with some force with his palms, keeping

up the points of the fingers to prevent their coming in contact with the hot pan. After one hour's good rubbing, the leaves are taken out and thrown into a large coarse bamboo sieve; from this into a finer one, and again a still finer, until three sorts of tea have been separated. The first or largest sort is put into the funnel of a winnowing machine, which has three divisions of small traps below to let the tea out. A man turns the wheel with his right hand, and with the left regulates the quantity of tea that shall fall through the wooden funnel above, by a wooden slide at the bottom. As the tea falls through gently, and in small quantities, the blast from the fan blows the smaller particles to the end of the machine, where they are intercepted by a circular movable board placed there. The dust and smaller particles are blown against this board, and fall out at an opening at the bottom into a basket placed there as a receptacle. The next highest tea is blown nearly to the end of the machine, and falls through a trough on the side into a basket. This tea is called *young hyson*. The next being a little heavier, is not blown quite so far; it falls through the same trough, which has a division in the middle near the centre of the machine. A basket is placed beneath to receive the tea which is called *hyson*. The next, which is still heavier, falls very near to the end of the fan; it is in small balls, and is called *gunpowder* tea. The heaviest falls still closer to the fan, and is called *big gunpowder*. It is two or three times the size of the gunpowder, each ball being composed of several young leaves, adhering firmly together. This sort is afterwards put into a box, and cut down by a sharp instrument to the size of gunpowder tea, with which it is mixed.

The different sorts are next put into fine bamboo sieves, and all bad leaves and pieces of sticks are carefully picked out by women and children, when it undergoes a second drying in the pans, and rolling and rubbing as before. A finely pounded and sifted mixture of indigo and sulphate of lime is now added, in the proportion of a tea spoonful to 14 lbs. of the leaves, and intimately mingled with them in the pan, by which a uniform colour is imparted to the whole. The indigo imparts the colour, and the sulphate of lime fixes it; but no additional flavour is hereby obtained.

Mr Bruce observes, that the leaves both for the black teas and the green, are plucked from the same trees; and that the difference lies in the manufacture of the leaves alone.

The green tea gatherers are accommodated with a small basket each, having a strap passed round the neck, so as to let the basket hang on the breast. With one hand the person holds the branch, and with the other plucks the leaf, one at a time taking as high as the souching leaf; a small piece of the lower end of the leaf is left for the young leaf to shoot up close to it, and not a bit of the stalk must be gathered. This makes the process very tedious. The black tea maker, on the contrary, plucks the leaves with great rapidity with both hands, using the fore-finger and thumb, and collects them in the hollow of the hand, emptying them occasionally into a basket. This process he accomplishes with inconceivable quickness. The quality of the tea depends upon the size of the leaves employed, and their age, and time of plucking.

To damaged black teas, the leaves of the *olea fragrans*, or sweet scented olive, and another aromatic plant, are added, in the proportion of a pound of these leaves to a box of tea. This improves the flavour without adding any thing that is pernicious.

In order to afford some idea of the labour of tea manufacture, Mr Bruce gives the following statement. To manufacture 80 lbs. of black tea per day, 25 tea gatherers are requisite, and 10 driers and sorters. To produce 92 lbs of green tea, 30 gatherers, and 16 driers and sorters are requisite. This supposes the day to be fine and sunny throughout. If rainy, one half may be deducted.

The produce of all the tea tracts in Assam, in 1839, is estimated at 5274 lbs.; in 1840, at 11,160 lbs.

The cultivation of the tea plant has only been commenced in this district lately. It might be increased to a very great extent, as the ground suitable for it is most ample. At present the quality and quantity of the produce must be influenced very much by the state of the trees, and by the labourers employed being as yet not sufficiently trained to the manufacture.

Mr Bruce says, that the Chinese method of digging a hole and putting in a handful of seeds of the tea plant, does not succeed so well in Assam as putting two or three seeds on small ridges of earth, and covering them over. As the plants grow very slender, he advises to put four or five close together, when they will grow up and form a bush. Plants raised from seed produce a small crop in three years; but they do not come to maturity till six years. It is said they live to the age of forty or fifty years.*

Coffee, *(coffea Arabica.)* Natural family *rubiaceæ*. *Pentandria monogynia* of Linnæus.

In the Arabic language, *quahouch* is the name for the liquor of cöffee; in Turkish *cahney*, hence the common name coffee.

The coffee tree is of low stature, seldom exceeding twelve feet in height; slender, and at the upper part dividing into long trailing branches. The bark is almost smooth, and of a brown colour. The leaves are elliptical, smooth, entire,

* Edin. Phil. Journal, 1840,

pointed, waved, three to four inches long, placed opposite on short footstalks. They are ever-

147.

Coffee.

green, and somewhat resemble those of the Portuguese laurel. The flowers are white, in form not unlike those of the jessamine. They are axillary, on short footstalks; or sessile, two or three together. The calyx is very small, tubular, and five toothed. The corolla is monopetalous, funnel-shaped, cut at the limb into five reflexed, oval, or lanceolate segments. The fruit which succeeds is a red berry, resembling a cherry, and having a pale, insipid, and somewhat glutinous pulp, inclosing two hard oval seeds, each about the size of an ordinary pea. One side of the seed is convex, while the other is flat, and has a little straight furrow inscribed through its longest dimension; while growing, the flat sides of the seeds are towards each other. These seeds are immediately covered by a cartilaginous membrane, which has received the name of the *parchment*.

Some botanists have enumerated two distinct species of the coffee tree. The *c. Arabica*, and *c. occidentalis;* others, again, are of opinion that the different sorts are only varieties, resulting from soil, climate, and mode of culture. The tree is a native of Arabia Felix, and Ethiopia, and was first introduced to the notice of Europeans by Rauwolfius, in 1573; but Alpinus, in 1591, was the first who scientifically described it. The Dutch were the first to introduce the plant into Europe. Having procured some berries at Mocha, which were carried to Batavia, and there planted, a specimen was sent to Amsterdam in the year 1690, by governor Wilson, where it bore fruit, and produced many young plants. From these, the East Indies, and most of the gardens of Europe, were furnished. It was first cultivated in Britain by bishop Compton, in 1696. In 1714 a plant was presented by the magistrates of Amsterdam to the French king, Louis XIV. This plant was placed at Marley under the care of the celebrated Jussieu; and from this source plants were forwarded some years after to the French islands in the West Indies, from whence all the coffee plants now found there derived their origin.

The use of coffee as an alimentary infusion was known in Arabia, where the plant is supposed to have been indigenous, long before the period just mentioned. All authorities agree in ascribing its introduction to Megalleddin, mufti of Aden, in Arabia Felix, who had become acquainted with it in Persia, and had recourse to it medicinally when he returned to his own country. The progress which it made was by no means rapid at first, and it was not until the year 1554 that coffee was publicly sold at Constantinople. Its use had, in the meanwhile, been much checked by authority of the Syrian government on the ground of its alleged intoxicating qualities: but more probably because of its leading to social and festive meetings incompatible with the strictness of Mahommedan discipline.

A similar persecution attended the use of coffee soon after its introduction into the capital of Turkey, where the ministers of religion having made it the subject of solemn complaint that the mosques were deserted while the coffee houses were crowded, these latter were shut up by order of the mufti, who employed the police of the city to prevent any one from drinking coffee. This prohibition it was found impossible to establish, so that the government, with that instinctive facility so natural to rulers of converting to their own advantage the desires and prejudices of the people, laid a tax upon the sale of the beverage, which produced a considerable revenue.

The consumption of coffee is exceedingly great in Turkey, and this fact may be in a great measure accounted for by the strict prohibition which the Moslem religion lays against the use of wine and spirituous liquors. So necessary was coffee at one time considered among the people, that the refusal to supply it in reasonable quantity to a wife, was reckoned among the legal causes for a divorce. The Turks drink their coffee very hot and strong, and without sugar; occasionally they put in, when boiling, a clove or two bruised, or a few seeds of starry aniseed, or some of the lesser cardamums, or a drop of essence of amber.*

Much uncertainty prevails with respect to the first introduction of coffee into use in the western parts of Europe. The Venetians, who traded much with the Levant, were probably the first to adopt its use. A letter, written in 1615 from Constantinople, by Peter de la Valle, a Venetian, acquaints his correspondent with the writer's intention of bringing home to Italy some coffee, which he speaks of as an article unknown in his own country. Thirty years after this, some gentlemen returning from Constantinople to Marseilles, brought with them a supply of this luxury, together with the vessels required for its preparation; but it was not until 1671 that the

* Ellis's History of Coffee.

first house was opened in that city for the sale of the prepared beverage.

In 1671, an Armenian named Pascal, set up a coffee house in Paris, but meeting with little encouragement he removed to London. He was succeeded by other Armenians and Persians, but not with much success, for want of address and proper places to dispose of it; genteel people not caring to be seen in those places where it was to be sold. However, not long after, when some Frenchmen had fitted up for the purpose spacious apartments in an elegant manner, ornamented with tapestry, large looking-glasses, pictures, and magnificent lustres, and began to sell coffee, with tea, chocolate, and other refreshments, they soon became frequented by people of fashion and men of letters; so that in a short time the number in Paris increased to three hundred.

Coffee houses date their origin in London from an earlier period. The first was opened in George Yard, Lombard Street, by one Pasqua, a Greek, who was brought over in 1652 by a Turkey merchant named Edwards.

The first mention of coffee that occurs in our statute books, is found in the act 12th Car. ii. cap. 24, (Anno 1660,) whereby a duty of fourpence per gallon, to be paid by the maker, was imposed upon all coffee made and sold: three years after this, coffee houses were directed to be licensed by the magistrates at quarter sessions.

Coffee cannot be cultivated to advantage in climates where the temperature at any time descends below fifty-five degrees of Fahrenheit's scale. The trees flourish most in new soils on a gentle slope, where water will not lodge about the roots. In exposed situations it is necessary to moderate the scorching heat of the sun by planting rows of umbrageous trees at certain intervals throughout the field.

Coffee trees are usually raised from seed in nursery grounds, and are afterwards planted out at regular distances, which vary according to the nature of the soil. Where this is very dry or gravelly, the trees seldom rise higher than six feet, and may be planted five feet apart; but in rich soils, where they attain the height of nine or ten feet, or more, the plants should not be so crowded, and intervals of eight or ten feet should be left between them.

It is well known, says Mr Ellis, that coffee imported from the West Indies does not equal in its flavour that produced in Arabia and other parts of the East; and it is commonly imagined that this inferiority is principally owing to local causes, and is therefore incapable of being remedied. The seed of the West India coffee, from growing in a richer soil, and more humid atmosphere, is larger than that of Arabia. Though there is reason for believing that the superior quality of Turkey and East India coffee is not altogether to be referred to the influences of soil and climate, but depends, in part at least, upon the age to which the seeds are kept before they are brought into consumption. Trees planted in a light soil, and in dry and elevated spots, produce smaller berries, which have a better flavour than those grown in rich, flat, and moist soils: the weight of produce yielded by the latter is, however, double that obtained from the former; and as the difference in price between the two is by no means adequate to cover this deficiency of weight, the interest of the planter naturally leads him to the production of the largest but least excellent kind. Mr Ellis further states the following results of his experience.

New coffee will never parch or mix well, use what art you will. This proceeds from the natural clamminess of the juices of the grain, which requires a space of time proportioned to its quantity to be wholly destroyed.

The smaller the grain, and the less pulp the berry has, the better the coffee, and the sooner it will parch, mix, and acquire a flavour.

The drier the soil, and the warmer the situation, the better will be the coffee it produces, and the sooner will it acquire a flavour.

The larger and the more succulent the grain, the worse it will be; the more clammy, and the longer in acquiring a flavour.

The worst coffee produced in America will, in a course of years, not exceeding ten or fourteen, be as good, parch and mix as well, and have as high a flavour as the best we now have from Turkey; but due care should be taken to keep it in a dry place, and to preserve it properly.

Small grained coffee, produced in a dry soil and warm situation, will be matured in three years.

The trees begin bearing when they are two years old; in their third year they are in full bearing. The produce of a good tree is from $1\frac{1}{2}$ to 2 lbs. of berries. The aspect of a coffee plantation during the period of flowering, which does not last longer than one or two days, is very interesting. In one night the blossoms expand themselves so profusely, as to present the same appearance which has sometimes been witnessed in England when a casual snow storm at the close of autumn has loaded the trees while still furnished with their full complement of foliage. The mode of culture of coffee in Arabia Felix is thus described by La Roque. The coffee tree is there raised from seed, which the natives sow in nurseries, and plant them out as they have occasion. They choose for their plantations a moist shady situation on a small eminence, or at the foot of the mountains, and take great care to conduct from the high grounds little rills of water in small channels to the roots of trees; for it is absolutely necessary that they should be constantly watered, in order to produce and ripen

the fruit. For that purpose, when they remove or transplant the tree, they make a trench three feet wide, and five feet deep, which they line or cover with stones, that the water may the more readily sink deep into the earth with which the trench is filled, in order to preserve the moisture from evaporating. When they observe that there is a good deal of fruit upon the tree, and that it is nearly ripe, they turn off the water from the roots, to lessen that succulency in the fruit which too much moisture would occasion. In places much exposed to the south, they plant their coffee trees in regular lines, sheltered by a kind of poplar tree, which extends its branches on every side to a great distance, affording a necessary shade from the intense heat of the sun. The seeds are known to be ripe when the berries assume a dark red colour, and if not then gathered will drop from the trees. The planters in Arabia do not pluck the fruit, but place cloths for its reception beneath the trees, which they shake, and the ripened berries drop readily. These are afterwards spread upon mats and exposed to the sun's rays, until perfectly dry, when the husk is broken with large heavy rollers made either of wood or of stone. The coffee thus cleared of its husk is again dried thoroughly in the sun, that it may not be liable to heat when packed for shipment.

The method employed in the West Indies differs from this. Negroes are set to gather such of the berries as are sufficiently ripe, and for this purpose are provided each with a canvas bag having an iron ring or hoop at its mouth to keep it always distended, and this bag is slung round the neck so as to leave both hands at liberty. As often as this bag is filled, the contents are transferred to a large basket placed conveniently for the purpose. When the trees are in full bearing, an industrious man will pick three bushels in a day. If more are gathered, proper care can hardly be exercised in selecting only the berries that are ripe. It is the usual calculation, that each bushel of ripe berries will yield ten pounds weight of merchantable coffee.

In curing coffee it is sometimes usual to expose the berries to the sun's rays in layers, five or six inches deep, on a platform. By this means the pulp ferments in a few days, and having thus thrown off a strong acidulous moisture, dries gradually during about three weeks: the husks are afterwards separated from the seeds in a mill. Other planters remove the pulp from the seeds as soon as the berries are gathered. The pulping mill used for this purpose consists of a horizontal fluted roller, turned by a crank and acting against a movable breast board, so placed as to prevent the passage of whole berries between itself and the roller. The pulp is then separated from the seeds by washing them, and the latter are spread out in the sun to dry them. It is then necessary to remove the membranous skin or parchment, which is effected by means of heavy rollers running in a trough wherein the seeds are put. This mill is worked by cattle. The seeds are afterwards winnowed to separate the chaff, and if any among them appear to have escaped the action of the roller, they are again passed through the mill.

The roasting of coffee for use is a process which requires some nicety; if burned, much of the fine aromatic flavour will be destroyed, and a disagreeable bitter taste substituted. The roasting is now usually performed in a cylindrical vessel which is continually turned upon its axis over the fire-place, in order to prevent the too great heating of any one part, and to accomplish the continual shifting of the contents. Coffee should never be kept for any length of time after it has been roasted, and should never be ground until the moment of its infusion, or some portion of its fine flavour will be dissipated.

The quantity of coffee consumed in Europe is very great. Humboldt estimates it at nearly one hundred and twenty millions of pounds, about one fourth of which is consumed in France. Since the time that this estimate was made, a vast increase has been experienced in the use of coffee in England. This was at first occasioned by the very considerable abatement made in the rate of duty, and the public taste has since been continually growing more and more favourable to its consumption.

More than sixty years ago, Dr Fothergill strenuously urged this reduction of the duty, predicting the increased consumption which has actually occurred.

Coffee possesses both an aromatic and narcotic principle. The flavour and taste which at first are both rather repulsive, become by habit agreeable and grateful. Its effects are stimulating, soothing, and exhilarating, in a calm and moderate degree, unlike the turbulent effects of fermented liquors. It is more stimulating than tea, and to some constitutions proves too heating and exciting; in general, however, it is grateful to the stomach, and seems to aid digestion if taken an hour or two after a full meal. It possesses little nutritive qualities in itself, though conjoined with sugar and cream, it may be reckoned a nourishing drink. The addition of much sugar, however, is apt to make the beverage disagree with weak stomachs, and to cause acidity.

Chocolate, or Cacao *(theobroma cacao)*. Natural family *byttneriaceæ; polyadelphia, decandria*, Linnæus. Linnæus named this plant *theobroma*, or "food for the gods," from the excellent nature of its seeds. The Mexicans call the beverage composed of the pounded seeds, *chocolate*.

The tree is a very handsome one, about twelve or sixteen feet high; the trunk is upright, and about five feet long; the wood is light, and of a

white colour; the bark is brownish. The leaves are lanceolate, oblong, bright green, quite entire; the flowers are small, reddish, and inodorous. The fruit is smooth, of a yellow or red tinge, and about three inches in diameter; the rind is fleshy, about half an inch in thickness, flesh-coloured; within the pulp white, of the consistence of butter, separating from the rind when ripe, and adhering only to it by filaments, which penetrate it and reach to the seeds. Hence it is known when the seeds are ripe, by the rattling of the capsule when it is shaken. The pulp has a sweet and not unpleasant taste, with a slight acidity. It is sucked and eaten raw by the natives. The seeds are about twenty-five in number; when fresh they are of a flesh colour; gathered before quite ripe they preserve them in sugar, and thus they are very grateful to the palate. They quickly lose their power of vegetation if taken out of the capsule, but kept in it they preserve that power for a long time. The tree bears leaves, flowers, and fruit, all the year through; but the usual seasons for gathering the fruit are June and December. In two years it is above three feet high, and spreads its branches, not more than five of which are suffered to remain: in three years it begins to bear fruit. A tree yields from two to three pounds of seeds annually. The seeds are nourishing and agreeable to most people, and are in general use in South America, and in the West India islands.

The seeds of the cacao were made use of as money in Mexico, in the time of the Aztec kings, and this use of them is still partially continued, the smaller seeds being employed for the purpose. The lowest denomination of coined money current in Mexico is of the value of about sixpence; and as there must arise many petty transactions of business to a lower amount, the convenience of these seeds, six of which are reckoned as of the value of one halfpenny, must needs be very great.

Cacao is principally used after having been made into cakes, to which the name of chocolate is given. The method anciently employed by the Indians in making these cakes, was simply to roast the seeds in earthen pots, and after clearing them from the husks, which by reason of the heat employed could be easily removed, the naked seeds were bruised between two stones, and made up with the hands into cakes. The process at present used by Europeans does not differ greatly from that just described: more care is taken in grinding the seeds after they are roasted, so as to convert them into a paste which is perfectly smooth, and some flavouring ingredients are added, according to the taste of the people who are to consume the chocolate. Cloves and cinnamon are much used for this purpose by the Spaniards; other aromatics, and even perfumes, such as musk, and ambergris, have sometimes been added; but the principal flavouring ingredient used with cacao is vanilla, a short notice of which we subjoin. The intimate mixture of these substances having been effected, the whole is put while yet hot into tin moulds, where it hardens in cooling, and in this form, if preserved from the air, it will keep good for a considerable time. Chocolate is not very much consumed in England; it is in greater esteem in France. It forms the ordinary breakfast in Spain; and in Mexico, according to Humboldt, it is not considered an object of luxury, but rather of prime necessity.

Vanilla *(vanilla aromatica)*, belongs to the natural family *orchideæ; gynandria, monandria*, Linnæus. It is a native of Mexico, and of some parts of India. The Spaniards found its fruit in use among the Aztecs at the time of their first invasion of Mexico. At this day, although a considerable quantity of vanilla pods is collected in that state for the purpose of exportation, the people do not themselves employ them in the manufacture of chocolate, the only use to which they have ever been anywhere applied, conceiving them to be possessed of unwholesome properties.

148.

The Vanilla.

The vanilla is a climbing plant; its leaves are lanceolate and ribbed, eighteen inches long, and three inches broad. Its flowers are white, intermixed with stripes of red and yellow colours; these are succeeded by long and slender pods, which at first are green, but become yellow as they ripen, and are then collected for use. The cavity of the pod contains, besides its numerous seeds, a substance which is black, oily, and balsamic; when recently gathered this is humid, and its odour is said to induce a kind of temporary intoxication. The pods are harvested during the three latter months of the year, and are carefully dried by exposure to the sun's rays until they are made warm, in which state they are wrapped in woollen cloths, to promote and absorb evaporation. By this process the vanilla acquires a black hue, with a somewhat silvery appearance. Five of the pods, thus treated, will usually weigh one ounce. The pods and seeds have a pleasing smell, somewhat like Peru balsam, or the tonquin bean.

The vanilla plant is very easily propagated by cuttings, as it shoots out roots at every joint; these, each about a foot in length, are planted at the root of the tree about which it is intended to climb. These plants will yield pods in their third year, and each will continue to furnish about fifty annually for thirty or forty years.

What is a singular advantage in that climate, no insect will attack this plant. They require very little moisture.

The Hop Plant *(humulus lupulus)*. Nat. fam. *urticeæ; diœcia, pentandria*, Linnæus. The

149.

The Hop.

hop has been cultivated in Europe, from the very earliest records, for the sake of its flowers, which are used for preserving beer, and imparting a bitter and narcotic quality to that liquid. Although indigenous both in Scotland and Ireland, its culture was not introduced into England till the reign of Henry VIII., when it was imported from Flanders. It is little cultivated either in Ireland or Scotland, owing to the moist nature of their autumnal seasons. The hop, like all the diœcious family, bears its flowers on separate plants; the female plant, therefore, is alone cultivated. There are several varieties raised in Kent and Surrey, as the Flemish, Golding, Canterbury. The first is the most hardy, differing little from the wild plant; the second is an improved variety, and highly productive; but more liable to the disease of blight than the other. The hop grows only in rich soils, and prefers a deep loam with a dry bottom, a sheltered situation, exposed to the south or south-west, but, at the same time, not so confined as to prevent a free circulation of air. The soil requires to be well pulverized and manured previously to planting. In hop districts the ground is generally trenched, either with the plough or spade. The mode of planting is generally in rows, six feet apart, and the same distance in the row. Five, six, or seven plants are generally placed together in a circular form, and at a distance of five or six feet from each other. The plants or cuttings are procured from the most healthy of the old shoots; each should have two joints or buds; from the one which is placed in the ground springs the root, and from the other the stalk. Some plant the cuttings at once where they are to remain; and others rear them for a year in nurseries, and then transplant them. An interval crop of beans or cabbages is generally taken the first year. The poles are placed to the plants generally the second year, at first only five or six feet in length; in the third year are substituted poles of sixteen feet in length, from four to six poles to each circle of plants, as they now acquire their perfect dimensions, and come into full bearing. The Spanish chestnut affords the most durable wood for poles, and, accordingly, is much grown in Kent, the chief hop county, for this purpose. The after culture of the hop consists in stirring the soil, and keeping it free from weeds; in guiding the shoots to the poles, and sometimes tying them, for that purpose, with withered rushes; in eradicating any superfluous shoots which may arise from the root, and in raising a small heap of earth over the root, to prevent any more shoots from rising. Hops are known to be ready for gathering when the chaffy capsules acquire a brown colour and a firm consistence. Each chaffy capsule, or leafed calyx, contains one seed. Before these are picked, the poles, with the attached stalks, are pulled up, and placed horizontally on frames of wood, two or three poles at a time. The hops are then picked off by women and children. After being carefully separated from the leaves and stalks, they are dropped into a large cloth, hung all round within side the frame on tenter hooks. When the cloth is full the hops are emptied into a large sack, which is carried home, and the hops laid on a kiln to be dried. This is always done as soon as possible after they are picked, as they are apt to sustain considerable damage, both in colour and flavour, if allowed to remain long in sacks in the green state in which they are pulled. In very warm weather, and when they are pulled in a moist state, they will often heat in five or six hours; for this reason the kilns are kept constantly at work, both night and day, from the commencement of the hop harvest till the termination. The operation of drying hops is not materially different from that of drying malt, and the kilns are of the same construction. The hops are spread on a hair cloth, from eight to twelve inches deep, according as the season is dry or wet, and the hops ripe or immature. When the ends of the hop stalks become quite shrivelled and dry, they are taken off the kiln, and laid on a boarded floor till they become quite cool, when they are put into bags. The bagging of hops is performed in the following manner: In the floor of a room, where the hops are laid to cool, there is a round hole or trap, equal to the mouth of a hop bag. After tying a handful of hops in each of the lower corners of a large bag, which serve afterwards for handles, the mouth of the bag is fixed securely to a strong hoop, which is made to rest on the edges of the hole; and the bag itself being then dropped through the trap, the packer goes into it, when a person, who attends for the purpose, puts in the hops in small quantities, in order to give the packer an opportunity of packing and trampling

them as hard as possible. When the bag is filled, and the hops packed in so hard as that it will hold no more, it is drawn up, unloosed from the hoop, and the end sewed up, other two handles having been previously formed in the corners, in the manner already mentioned. The brightest and finest coloured hops are put into pockets, or fine bagging, and the brown into coarse or heavy bagging. The former are chiefly used for making fine ales, and the latter by the porter brewers. But when hops are intended to be kept two or three years, they are put into bags of strong cloth, and firmly pressed so as to exclude the air.

The stripping and sacking of the poles succeeds to the operation of picking. The shoots or bind being stripped off such poles as are not decayed, are set up together in a conical pile of three or four hundred, the centre of which is formed by three stout poles bound together a few feet from the top, and their lower ends spread out.

The hop crop is liable to great variation, and to many casualties. In a good season an acre will produce twenty cwt.; in a bad season only two or three cwt., and sometimes none. From ten to twelve cwt. is reckoned an average crop. The quality is estimated by the abundance or scarcity of an unctuous clammy powder which adheres to them, and by their bright yellow colour.

The expenses of forming a hop plantation are very great; but once in bearing, it will continue so for ten or fifteen years before it requires to be renewed. The hop culture in England, like that of the vine in France, is only fitted for cultivators of considerable capital, who can retain the produce from years of abundance to those of scarcity. It is calculated on an average, that the hop crop fails almost entirely every fifth year, when the price will rise from £2 to £30 per cwt.

The hop is peculiarly liable to diseases. When young it is devoured by flies of different kinds; at a more advanced stage it is attacked by the green fly, red spider, and ottor moth, the larvæ of which prey on every part, even to the roots. The honey dew often injures the plants, as also other kinds of blight.

The use of hops in beer is to prevent it becoming sour, and to assist in its clarification. This it does both by its aromatic and narcotic principle, as well as by its astringent effects on the mucilage of the wort.

It is used in medicine. A decoction of the roots are sodorific, and of the flowers anodyne. A pillow case stuffed with fresh hops will procure sleep in some affections of the brain when other anodynes fail.

The stalk and leaves dye wool yellow; and the fibrous part of the stalks has been manufactured into a strong cloth.

Tobacco (*nicotiana tabacum*). Nat. fam. *solaneæ; pentandria, monogynia*, Linnæus. This

150.

Tobacco.

celebrated plant may properly find a place among those other narcotics which habit has rendered almost essential to man. The generic name *nicotiana* is derived from John Nicot of Nismes, in Languedoc, ambassador from the king of France to Portugal, who procured the seeds from a Dutchman, who had obtained them from Florida. The first plant was said to have been presented to Catherine de Medicis, whence the French name *herbe à la reine*. The common name tobacco is the appellation of a district in Mexico.

The root is annual, large, long, and fibrous; the stalk is erect, strong, round, hairy, branched towards the top, and rises five or six feet in height; the leaves are numerous, large, oblong, pointed, entire, veined, viscous, of a pale green colour, without footstalks, and follow the stem downwards; the bracteæ are long, linear, and pointed; the flowers terminate the stem and branches in loose clusters or panicles; the corolla is monopetalous, funnel-shaped, with a long hairy tube, which gradually swells towards the limb, where it divides into five folding acute segments of a reddish colour; the calyx is hairy, about half the length of the corolla, and is cut into five narrow segments; the five filaments are bent inwards, tapering, and crowned with oblong antheræ; the germen is oval, and supports a long slender style, terminated by a round cleft stigma; the capsule is oval, and divided into two cells, which contain many small roundish seeds. It is indigenous to America, and flowers in July and August.

There are upwards of twelve species of this genus; but the kinds cultivated are the *n. tabacum*, and *n. rustica*, of which the first is greatly preferred. The taste and even odour of this nar-

cotic plant are nauseous, and yet it has obtained a more universal popularity than almost any other kind of luxury, not even excepting the famous betel nut of the east. According to Linnæus, tobacco was known in Europe from 1560. It was brought to England from Tobago in the West Indies, or Tobasco in Mexico, by Ralph Lane, in 1586; but only the herb for smoking. Sir Walter Raleigh is said to have first introduced this practice. In the house in which he lived at Islington, are his arms on a shield, with a tobacco plant on the top. Smoking has consequently been common in Europe for upwards of two centuries.

Tobacco is a powerful narcotic and stimulant, especially acting on the stomach and intestines, proving both emetic and purgative, and in large doses extinguishing life. The essential oil applied to a wound is said by Redi to prove as effectually fatal as the bite of a viper. The experiments of Albinus do not altogether confirm this however. The oil occasioned vomiting and death when given to pigeons. To those persons not accustomed to its daily use, snuff or tobacco, taken in any considerable quantity, produces nausea, vomiting, fainting fits, and even death. Habit, however, has rendered its use grateful as a stimulant, both to the savage and the philosopher; and the longer it is indulged in, the more man becomes a slave to its temporary soothing and exhilarating effects. According to Du Tour, not less than a hundred volumes have been written against it, of which a German has preserved the titles. Among these works is that of James I. of England, who violently opposed it. The Grand Duke of Moscow forbade its entrance into his territory under pain of the knout for the first offence, and death for the next. The emperor of the Turks, king of Persia, and Pope Urban VIII. issued similar prohibitions, all of which were as ridiculous as those which attended the first introduction of coffee or Jesuit's bark. At present all the sovereigns of Europe, and most of those of other parts of the world, derive a considerable part of their revenue from tobacco.

This plant is cultivated in Europe as far north as Sweden, and is also raised in China, Japan, and other tropical countries. The common tobacco is the kind principally cultivated. The *rustica* is reckoned a hardier sort for the climate of Europe. It has been cultivated in various parts of Britain; but is prohibited, partly to encourage the American trade, and partly because it is deemed a too exhausting crop for the soil. In Germany, most families who have gardens raise the *t. rustica* for their own use; but as they do not know how to manufacture it into snuff or chewing tobacco, it is not much valued.

Long, in his history of Jamaica, describes the manner of its cultivation thus: When a regular plantation of tobacco is intended, several beds are prepared, well turned up with the hoe. The seed, on account of its smallness, is mixed with ashes, and sown upon them a little before the rainy season. The beds are then raked or trampled with the feet, to make the seed take the sooner. The plant appears in two or three weeks. So soon as they have acquired four leaves, the strongest are drawn up carefully, and planted in the tobacco field by a line, at the distance of about three feet from each plant; this is done either with a stick or with the finger. If no rain falls, it should be watered two or three times, to make it strike root. Every morning and evening the plants must be surveyed, in order to destroy a worm which sometimes invades the bud. When they are grown about four or five inches high, they are to be cleared from weeds and moulded up; and as soon as they have eight or nine leaves, and are ready to put forth a stalk, the top is nipped off, in order to make the leaves longer and thicker. After this the buds, which sprout at the joints of the leaves, are all plucked, and not a day suffered to pass without examining the leaves, to destroy a large caterpillar which is sometimes very destructive to them. When they are fit for cutting, which is known by the brittleness of the leaves, they are cut with a knife close to the ground; and after being left to lie there some little time, are carried to the drying shed, or house, where the plants are hung up by pairs, upon lines or ropes stretched across, leaving a space between, that they may not touch one another. In this state they remain to sweat and dry. When they become perfectly dry, the leaves are stripped from the stalks and made into small bundles, tied with another leaf. These bundles are laid in heaps, and covered with blankets. Care is taken not to overheat them; for which reason the heaps are laid open to the air from time to time, and spread out. This operation is repeated till no more heat is perceived in the heaps, and the tobacco is then stored in casks for exportation.

In the manufacture of tobacco the leaves are first cleansed of any earth or decayed parts; next they are gently moistened with salt and water, or water in which salt, along with other ingredients, has been dissolved, according to the taste of the fabricator. This liquor is called tobacco sauce. The next operation is to remove the midrib of the leaf; then the leaves are mixed together, in order to render the quality of whatever may be the final application equal; next they are cut into pieces with a fixed knife, and crisped or curled before a fire. The succeeding operation is to spin them into cords, or twist them into rolls, by winding them with a kind of mill round a stick. These operations are all performed by the grower; and in this state of rolls

the article is sent from America to other countries, where the tobacconists cut it into chaff-like shreds by a machine like a straw cutter, to be used as smoking tobacco. They also form it into small cords for chewing, or dry and grind it for the various kinds of snuffs. The three principal kinds of these are called rappee, Scotch or Spanish, and thirds. The first is only granulated, the second is reduced to a very fine power, and the third is the siftings of the second sort. The best Havannah segars are made from the leaves of *n. repanda.* The Indians of the rocky mountains of North America prepare their tobacco from the *n. quadrivalvis* and *n. nana.*

The moderate use of tobacco, like that of the other stimulants used by man, may be harmless, or even, in some respects, and under certain circumstances of climate, &c., probably beneficial. Its inordinate use, however, is followed by those symptoms which characterize the action of all narcotics on the human body, such as loss of tone of the digestive organs, debility of the nervous system, and the diseases and premature decay consequent on such. A pallid countenance, indigestion, and not unfrequently impaired vision and loss of sight, follow an undue use of this herb in whatever way it is taken.

CHAP. XLI.

PLANTS USED FOR CLOTHING, CORDAGE, &C.—FLAX, HEMP, COTTON, NEW ZEALAND FLAX, &C.

Having in the preceding chapters treated of those vegetable substances used for the food of man, we now proceed to describe those which are employed for clothing and other useful purposes.

Many of the fibrous parts of vegetables possess considerable tenacity, especially the inner bark or true liber; and accordingly we find, that, among rude nations, the prepared bark of trees constitutes their chief clothing. In more advanced states of society, the fibres of smaller plants bleached, and wove into an artificial texture, form more comfortable and elegant substitutes. In the South sea islands the natives prepare for themselves robes of the inner bark of trees, having first beat and softened the fibre, and then sewed the strips together, so as to form a large cloak. In more northern climes the bark of the birch and other trees are also occasionally used along with the skins and furs of animals. If we endeavour to trace the first origin of woven garments, we must look to the cradle of all the arts and inventions of civilized man—to Palestine and Egypt. In the earliest history of the patriarchs we find frequent mention made of linen garments. Solomon imported flaxen yarn from Egypt, which was woven by his people into cloth; and fine linen is enumerated among the ornaments of the temple of Jerusalem. Herodotus mentions that the Greeks also derived their linen from Egypt; and we find that the mummies of that singular people were enveloped in many folds of linen of various textures, according to the rank of the persons embalmed; some of those envelopes being of a very fine texture and in wonderful preservation, even after a lapse of many thousand years.

Herodotus also mentions, that, in the temple of Minerva at Lindus, in Rhodes, there was kept a linen corslet of curious workmanship, which had belonged to Amasis king of Egypt, who flourished 600 years before the Christian era. Each thread of this corslet was composed of 360 filaments, and it was ornamented with cotton and gold. Pliny mentions that in his time a fragment of this cloth still remained, but that the curious touch of numerous visitors had reduced it to a mere relic. At the commencement of the Christian era, the use of linen was also well known, not only in Egypt, but in various parts of Europe. Pliny says, that the flax of Spain surpassed that of all other nations. He gives a description of the mode of raising and preparing flax; and it is singular to mark, that it differs little from the modern practice. The Romans preferred the use of woollen garments even to a late period of their history; but linen was used in their domestic establishments, and employed in making the sails and cordage of their navy.

Lint *(linum usitatissimum)*, from the Greek *linon*, and Latin *linum.* Natural family, *caryophylleæ; pentandria, pentagynia,* Linnæus. This is an annual slender upright plant, with fibrous stalks about the thickness of a crow quill, hollow, composed of soft woody matter, and a tough fibrous rind. The leaves are alternate, long, narrow, of a greenish gray. At the height of two and a half feet the single stem divides into several footstalks, in which are the flowers, with delicate blue petals. The ovary is large, globular, divided into ten cells, each containing a seed of an oblong form, smooth, shining, and unctuous to the feel, containing a large quantity of oil and mucilage. The plant thrives best in rich land; but it will grow on almost any soil. It impoverishes the ground very much, and, therefore, should never be sown two years on the same place. A field of lint, with its soft silken foliage and its delicate blue flowers, forms a very beautiful object; and such is the beauty of the blossom, that it is not unfrequently introduced as a garden ornament.

It is supposed that this plant was introduced into Britain some time subsequent to the Norman conquest, as it is not enumerated among the tithable articles of that period. It was not till

the year 1175 that flax and hemp were, by the council of Westminster, included among the tithable productions from whence the clergy had their dues.

Notwithstanding that the British government for many years held out every encouragement for the cultivation of both flax and hemp in this country, its production has rather declined than increased. Indeed, it was found by no means so profitable a crop for our soils as many other substances; and as it could readily be procured from abroad at a cheaper rate, we now wisely depend upon foreign importation, and devote our fields to more suitable and less scourging crops; yet in some of the counties a considerable quantity is still raised, both in the north of England and in Scotland and Ireland.

Russia, Holland, and America, supply Britain with flax and hemp seed, as also with considerable quantities of the raw products of them. The flax plant seems to flourish in all varieties of climate, in cold, in temperate, and in torrid regions. One species yields its products to Europe, North and South America, Africa, and Asia. The Hindoos cultivate it for the seed and the expressed oil alone, rejecting the stalks as useless.

There are numerous species of this plant. The perennial *(l. perenne)* may be cultivated for the same purposes as the other. It has several strong upright stalks, rising to the height of four or five feet. The leaves are small, alternate, narrow, and dark green. The flowers are in large clusters. The fibres are very strong and tenacious; but do not bleach so white, or become so soft and fine, as the common species.

Although flax is easy of growth, its quality depends very much on fitness of soil and situation. Low grounds, and those which have received deposits left by the occasional overflowing of rivers, or where water is found not very far from the surface, are deemed the most favourable situations for its culture. It is attributed to this last circumstance that Zealand produces the finest flax grown in Holland. Preparatory to the cultivation of this plant, it is not necessary that the ground should be very deeply furrowed by the plough, but it should be reduced to a fine friable mould by the repeated use of the harrow. Two or three bushels of seeds are required for each acre of ground, if scattered broad-cast; but half the quantity will produce a better crop if sown in drills. Care is taken to distribute the seed evenly, and the earth is then raked or lightly harrowed over. When flax is raised to be manufactured into cambric and fine lawns, double the quantity of seed is sown in the same space of grouud—the plants growing nearer to each other have a greater tendency to shoot up in long slender stalks; and as the same number of fibres are usually found in each plant, these will be of course finer in proportion.

The usual time for sowing the seed is from the middle of March to the end of April, and sometimes May. In some parts of the south of Europe the cultivators of flax sow part of their crop in the autumn. This is perhaps a judicious plan in low latitudes; but where the winter is severe, if this method were pursued, the tender shoots would be in danger of destruction from the frost. The plant blooms in June or July, and is considered ripe and fit for pulling towards the latter end of August. When the crop grows short and branchy, it is esteemed more valuable for seed than for its fibrous bark, and then it is not gathered until the seeds are at full maturity. But if the stalks grow straight and long, then all care of the seed becomes a secondary consideration, and the flax is pulled at the most favourable period for obtaining good fibres. Experience has shown that when the bloom has just fallen, when the stalks begin to turn yellow, and before the leaves fall, the fibres are softer and stronger than if left standing until the seed is quite matured.

It has been found from experience, that most seeds, though not quite mature when gathered, ripen sufficiently after being plucked, provided they be not detached until dry from the parent plant; all the sap which this contains contributing towards farther nourishing and perfecting the seed.

The Dutch avail themselves of this fact with regard to their flax crop. After pulling the plants they stack them. The seed by this means becomes ripe, while the fibres are collected at the most favourable period of their growth. They thus obtain both of the valuable products from their plants, and supply their less careful neighbours with the seeds.

The plants which have been sown thickly are liable, if left without support, to be laid by the wind, and consequently to be spoiled; provision is therefore made to prevent this accident. Forked sticks, a foot and a half or two feet high, are fixed in the ground in rows three or four feet asunder. Poles from ten to fifteen feet in length are then laid horizontally on the sticks, and long branchy brushwood is placed across these parallel rows of poles; this is laid very thick, and the vacancies are filled up with smaller brush. Oak brushwood is never employed for this purpose, as it is found to tinge the flax. Thus the whole forms a support and shelter to the plants, which, as they grow, find an effectual prop in the hanging brushwood. Another more simple and equally efficacious plan is pursued by some cultivators. Small ropes are extended both across and along the fields, intersecting at right angles, and fastened at their points of intersection; the whole is propped up by stakes fixed in the ground, and forms a kind of netting.

After the plants have been pulled and sorted,

they are either laid regularly across the field in handfuls, raised a little aslant, or are tied loosely in sheaves, and set upright upon their roots. The general practice is to leave the plants in the field twelve or fourteen days after they have been gathered in order to dry them. This method does not meet the approbation of intelligent cultivators, who consider it most judicious to dispense with the drying altogether. In some parts of France it is the custom to lay the flax on the ground for only a day or two. In Yorkshire the sheaves are immediately taken to the watering place. Flax intended for cambric is never so much dried, previously to watering, as that which is employed in the making of lawn, lace, or thread.

An experienced flax raiser is careful to sort his plants after pulling them, putting together those only which are of the same size and quality, as each kind requires a different treatment in the subsequent preparation.

The first operation which flax undergoes is called rippling, and this can be performed equally well whether the plants be green or dry. This is done to free the stalk part from the leaves and seed-pods called *bolls*.

The ripple is a kind of comb, consisting of six, eight, or ten long triangular teeth, set in a narrow piece of wood, so that their bases nearly touch each other. This being firmly fixed on a beam of wood, two persons sit, one at each end, and taking up the handfuls of flax, draw them repeatedly through the ripple; in a very short time each handful is by this means entirely divested of all its leaves and pods.

If the seed of the plants under operation is to be preserved, a large cloth is spread on the ground to receive the pods as they fall; these are then spread out in the sun, and when dry and hard the seeds are carefully sifted and winnowed from the husk. Those which separate spontaneously are reserved for sowing. The second and inferior sort is extensively used in the arts, and is known under the name of lintseed or linseed, from which linseed oil is obtained.

The delicate fibres of flax intended for cambric would be injured by the use of the ripple, and therefore the stalks are in that case divested of their seed, pods, and leaves, either by beating them with a wooden mallet, or by cutting them off with a wooden knife.

The flax, after being rippled, is placed in water to dissolve the gummy sap, by which the bark adheres to the ligneous stalk; to cause maceration, by promoting a slight fermentation of those parts which are not fibrous, and consequently to promote the more easy disengagement of the useful from the useless portion. This is called *water-retting*. A difference of opinion exists as to the superior efficacy of a running stream or a standing pool for the purpose. It is said that a running stream wastes the flax, while on the other hand it gives to it a greater degree of whiteness.

Hemp and flax impart somewhat of a poisonous quality to the water in which they are immersed. It was for a long time asserted, that if there were any fish in the water they quickly died; and if cattle were allowed to drink of it, the draught proved fatal. This may be the case where a very great quantity is soaked in a small pool; but where the volume of water employed is at all considerable, no such effects are produced. The exhalations proceeding from hemp and flax, when under maceration, are indeed very noisome. The great quantity of hemp soaked every summer in the lake of Agnano, in the south of Italy, is even said to increase the malaria of the immediate neighbourhood; but it has never been known to poison the fish or the frogs, or any other animal drinking of that water. An act was passed in the reign of Henry VIII. forbidding the watering of flax and hemp in any river or common pond, and this act still continues in force. Canals are therefore generally dug for the purpose. A canal of four feet in depth, forty feet long, and six broad, is found of sufficient extent to water the plants produced in one acre.

The bundles of flax are placed in regular layers in the pond, and loaded with large pieces of wood until the whole is immersed in water. Ten days is about the usual period of their remaining in this situation, but sometimes a fortnight is required. The proper time depends on various circumstances. The state in which the flax was pulled, whether green or approaching to maturity; the quality and temperature of the water, all have an effect on the length of time required for watering. It can only be known by trial when this operation is completed. If the flax feels soft to the touch, and if the rind separates easily from the stem, it having become brittle, then all that was required from the action of the water has been accomplished; the plants are consequently removed, spread thinly on heath or a stubble field, and turned about once a week until completely dry. In this manner of steeping, the flax soon gives to the water an inky tinge, and imbibes it again so strongly that much labour is required in its bleaching, and therefore many plans have from time to time been proposed to obviate this objection. It has been recommended, as a much better method, to subject the flax to the action of boiling water, or even to boil it for an hour or more, by which every advantage would be obtained of macerating the reed or *boon*, and separating the juices, while the bad effects attending long immersion in stagnant pools would be avoided.

The water-retting for very fine flax is more carefully performed; and in this process the advantages of running and still water are endea-

voured to be combined. The pit into which the water is introduced for this purpose is made three or four months before it is wanted. A pure stream from a soft spring, or where a small rivulet is always gently running through; the pit having only two small apertures at opposite sides for the ingress and egress of the water. This receptacle should be about five feet deep, narrow, and of a length proportionate to the quantity of flax under process. Poles with hooks attached to them are driven in along the sides, the hooks being rather below the surface of the water; a long pole, the whole length of the pit, is fixed into these hooks. The flax is then made into narrow bundles of about two and a half feet long and four feet high, and these being wrapped in straw, are immersed in the water, where they are kept securely by means of horizontal cross poles, which are then introduced between the long pole and the hooks.

Some cultivators do not steep the flax in water, but only spread it on the surface of grass ground, exposed to the air and moisture, which is called *dew-retting*.

As the fibre gains nothing, however, by maceration in water, it has been proposed, in order to shorten and simplify the process of separation from the woody parts, to omit the process of steeping entirely, and simply to dry and stack the lint when taken from the field as a crop of corn. Afterwards, by machinery, the capsules are separated, and the fibre detached. In this way there is less loss of seed, and less demand for labour at a busy season. The fibre has also all its original strength, part of which must be lost by the process of maceration; and the bleaching and clearing it of all colouring and mucilage must be an easier process from the diminished bulk of the material. Two patents have been taken out for this process, one in 1810, and the other by Messrs. Hill and Bundy, in 1817, the latter of whom also invented an ingenious machine for the purpose. This process, however, has not yet come into general use. On the first trials it was found that the flax proved too harsh and rough for the purpose of manufactures; and this objection does not seem to have been hitherto obviated.

For many ages it was the universal practice to separate the flax from the useless parts by hand-machinery, either by beating with mallets, or by the use of an instrument called a *break*. Even now, in those countries where flax is most cultivated, the hand-break is still used.

This instrument is a block of wood, about seven or eight feet in length, and seven or eight inches in breadth and thickness. Deep grooves are made in the wood, extending through its whole length, about an inch wide at bottom, and increasing in width in such a manner that the divisions thus formed may present rather sharp edges on the surface. Over this block of wood another block is fitted, one end of it being made fast by means of a hinge, and the other shaped into a handle. This upper block has two longitudinal edges, so shaped as to enter and fit into the corresponding grooves of the under part of the machine.

The person who is to perform the operation of breaking takes a quantity in his left hand, while with his right hand he holds the handle of the upper jaw of the break. The flax being put between the upper and under part, the former is raised up and let down several times with all the force of the operator; this breaks the reed without injuring the fibres which surround it, and at the same time effectually separates these from the cellular texture which united them, and which together with them formed the bark. By putting the flax between the two jaws the bruised refuse is partially separated from the fibres.

Some of the smaller particles still remain entangled among the flax; to get rid of these, another operation is required which is called *scutching*. The *scutch*, the instrument used for this purpose, is merely a kind of long wooden bat; and the scutching-frame is an upright board, fastened to a horizontal piece, which latter forms the foot-board. In the upright piece a semicircular incision is made, on which the workman places the flax, which he holds in one hand, while with the other he strikes it with the scutch; after giving it several strokes, he shakes it, replaces it on the board, and continues striking till it is sufficiently clean, and the fibres appear tolerably straight. The qualification of a good scutcher is to make as little waste as possible, while he perfectly cleanses the flax.

This manner of breaking and scutching the flax is very tedious and laborious. About seventy years ago a more expeditious method was invented in Scotland, and it has been found so advantageous, that the hand-break and scutcher are now seldom used in this country. The invention consists of a mill, having three indented cylinders placed in contact, and one above the other. The middle cylinder, by means of a water-wheel, or other motive power, is made to revolve with a quick motion, which is imparted to the other two through the intervention of cogs. The stalks are introduced between the upper and middle cylinders, a curved surface behind causes the flax to return again between the middle and lower cylinder, and this operation is continued till the *boon* is completely broken. The upper and under rollers are pressed against the middle one by means of weights.

The boon being now thoroughly broken, the fibres are freed from it likewise by means of the same mill, which gives motion to four arms projecting from a horizontal axle, and so arranged

as to strike in a slanting direction on the flax, imitating as much as possible the action of the hand-scutcher.

It is evident that this process cannot wholly free the fibrous parts from the smaller pieces of the reed, or from the gummy substance which still adheres to the filaments. To effect the entire disengagement of all extraneous matter, and to disentangle the fibres from between themselves, recourse is had to another operation called *heckling*.

The heckle is a square frame of hard wood, studded with rows of sharp-pointed iron pins, about four inches in length, half an inch in circumference and an inch apart from each other. The teeth are set in rows, disposed in a quincunx order. By this arrangement they more effectually divide the flax than if they were placed square; the teeth in that case would scarcely produce a better effect than a single row. Coarse or fine heckles are employed according to the quality of the flax; a coarse one is generally first used to disentangle the filaments, and then a finer one gives to them the last degree of preparation.

The heckle is firmly fixed to a bench before the workman, who, grasping a handful of flax in the middle, draws first one side and then the other through the teeth, till the whole is freed from all extraneous matter, and presents a series of smooth distinct filaments. Though this operation is apparently so simple, much practice and skill are required to perform it with little waste, and to produce even and continuous fibres.

Flax for cambric and fine lawn is dressed in a more delicate manner. After only slightly undergoing the process of scutching, it is not then consigned to the teeth of the heckle, but is merely scraped and cleansed with a blunt knife, on a soft skin of leather; thence it is carried to the spinner, who, with a brush made for the purpose, dresses each parcel previously to spinning it.

An account was published some years ago, in Sweden, of a method used in preparing flax so as to superadd all the finer qualities of cotton to those of linen fibres. The plants were boiled for many hours in a mixture of sea-water, birch ashes, and quicklime; then washed in the sea, and being subsequently rubbed and cleansed with soap, were laid out to bleach. By this process the flax lost one-half of its weight; but it is said that its superior quality more than compensated for the deficiency in quantity.

Berthollet likewise made experiments in bleaching flax, and succeeded in giving to its fibres the whiteness and softness of cotton. He subjected it to the action of chlorine, which indeed bleached it effectually, but at the same time injured its fibre; and although a thread was produced from it of considerable tenacity, yet this was a most troublesome operation, in consequence of the shortness of staple.

It was found that this chemical bleaching process had the remarkable property of reducing the finest flax and the coarsest hemp alike to one uniform fineness of fibre and colour, and that even the refuse from rope-walks might thus be made into a substance valuable in the arts.

The produce from the flax plant is extremely uncertain in quantity. It is affected by difference of soil and season, as well as by the degree of carefulness bestowed on its cultivation and preparation; these different circumstances causing a variation of from 280 to 980 lbs. per acre; but the average crop in the same area may be estimated at 560 to 700 lbs. of clean fibre available for spinning and weaving.

The quantity of seed produced from an acre of ground averages from six to eight bushels; sometimes, however, an acre yields ten or twelve bushels.

THE COTTON PLANT *(gossypium)*. Natural family *malvaceæ; monodelphia, polyandria*, Linnæus. There are several distinct species of cotton plants, and a great many varieties. Some are herbaceous annuals, others shrubs of three or four feet in height, and others again reach the size of trees of fifteen to twenty feet in height. The stems are smooth or hairy; leaves either three or five lobed, vine-shaped, cordate, blunt, or lanceolate. The blossom is large, with yellow or white petals, and a purplish centre; and to this succeeds an acuminated pod, which, on coming to maturity, bursts, and displays a profusion of white or yellowish down that forms the cotton of commerce. In the centre of this down are contained the seeds, varying in number from ten to thirty, according to the species, of a dark brown colour, and of an oleaginous nature.

The early history of the cotton plant is involved in obscurity, nor can we now ascertain in what region of the globe it was first cultivated and applied to purposes of domestic use. Herodotus, who had travelled into Egypt, and was familiar with its productions, does not describe the cotton plant as existing there, but gives some obscure hints of such a plant being in use in India. The inhabitants of India, says he, possess a kind of plant which, instead of fruit, produces wool of a finer and better quality than that of sheep; of this the natives make their clothes. When describing the corslet of Amasis, he accordingly designates cotton under the name of tree-wool, a combination of terms which the Germans use for the same substance at this day. His particularly detailing the linen garments of the Egyptians, and their mode of weaving linen cloth, as differing from that of the Greeks, while he omits all mention of the manufacture of cotton garments, would lead us to sup-

pose that this latter—the cotton plant, was unknown to the Egyptians; and that if they possessed cotton cloth at all, it was imported from India. The absence of all appearance of cotton amid the profusion of linen cloths which envelope their mummies, would also confirm the supposition, that, if not unknown, at least cotton cloth was extremely rare among them.

Pliny, however, in his work on Natural History, describes the cotton plant as a small shrub growing in Upper Egypt, called by some *xylon*, and by others *gossypium*, the seeds of which are surrounded by a soft downy substance of a dazzling whiteness, and which is manufactured into a cloth much esteemed by the Egyptian priests. This was five centuries after the time in which Herodotus wrote, and during this period the plant may have become more common.

In the present day the cotton plant is cultivated to a considerable extent in the Levant. From Pliny's account it would not appear that cotton was much used at Rome, even in the first century of the Christian era, nor for many centuries afterwards was its use introduced into Europe. But in the ninth century the Arabians, who were then in possession of Egypt, appear to have used cotton cloth for their ordinary garments; for one of the first remarks of two Arabian travellers, who went to China at that period, was, that the Chinese, instead of wearing cotton as they and their countrymen did, chiefly used silk stuffs.

It is probable, then, that the cotton plant first came from Persia to Egypt, from thence it spread into Asia Minor, and latterly to the islands of the Archipelago. In the time of Tournefort, who visited these islands, Milo was celebrated for its cotton. The cotton now raised in small quantity in the Cyclades possesses that dazzling whiteness which Pliny describes as the property of the Egyptian cotton.

It is a question not now easily solved, whether the cotton plant was originally a native of the West India islands and the continent of America. It is said that a species of cotton is found growing wild in some parts of America, distinct from that which the European settlers introduced from the old world; and it is also affirmed that the Mexicans, when first discovered, wore cotton garments stained with most vivid and brilliant colours, an art practised by the Aztecs, but which is now entirely lost. There can be no doubt, however, but that the colonists who took possession of the southern states of North America, disregarding the native productions of the soil, introduced the cotton plant from Smyrna at an early period of their settlement, and its culture has continued and greatly extended ever since. In Georgia the most abundant crops are annually produced of very superior cotton, known for the length and fineness of its fibre.

According to Humboldt, the cultivation of the cotton plant in the United States has increased in a prodigious ratio, and the production of cotton continues to be an object with the Americans of growing importance. "Sea Island" and "Upland" cotton are the terms used in commerce to designate the cotton which comes from Georgia. "These hieroglyphics in the Liverpool News," are fully explained in Captain Basil Hall's entertaining narrative of his travels in North America.

Near the Georgian coast are several small islands. It is on these insular spots that the finest cotton is grown, and from these it takes its name, which, however, is borrowed, in order to class under the same head cotton raised at various places on the main coast, and also in the swampy regions bordering on most of the great rivers. That which grows farther from the sea, and at a higher level, has acquired the name of upland cotton, and is of inferior quality.

The cotton tree is cultivated in most of the West India islands; and in South America this branch of agriculture has long been an object of attention. Until a very recent period, cotton formed one of the principal articles of exportation from Demerara; but its increased and cheaper production in many other countries has, notwithstanding the great and constantly increasing demand, lowered its price so considerably, that the Demerara planters have found it more to their advantage gradually to convert their cotton into sugar plantations. Much, however, is still grown in other parts of Guiana, and is known in commerce as Demerara cotton.

Among other nations, the Egyptians have, within the last few years, enormously increased the production of this article, and have become formidable rivals to other cotton cultivators. A very large quantity of an excellent quality is annually exported thence, to the great prejudice of the Smyrna and other markets.

In 1825 more than a hundred thousand bags of cotton were exported from Egypt to Great Britain; and although the supply has not continued so excessive as in that year of excitement and speculation, yet the importation thence still continues much beyond that from the whole West India islands. In the same year, and in 1826 and 1827, the exports of Egyptian cotton to France, entirely through the port of Marseilles, were immense. In 1828 and 1829 there was a glut. The immense department of the lazaretto of Marseilles, devoted to the reception of this and other products from plague countries, was then literally crammed with Egyptian cotton.

The cultivation of cotton is very extensively pursued in China; and in the time of Alexander the Great it was grown and spun in the Penj-ab. This valuable indigenous production did not be-

come an article of commerce from the Indies to this country until many years after the British had possessed their widely-extending eastern territory. It must be remembered, however, that antecedent to this period, though the Europeans did not import raw cotton from the East Indies, they imported a vast quantity of muslins and other manufactured cotton stuffs, which were superior to what we could produce until we called in the aid of machinery.

When the enterprising French traveller Bernier was in Hindostan (about the year 1666), Bengal was the mart for these cotton goods. "There is in Bengal," says he, "such a quantity of cotton and silks, that the kingdom may be called the common storehouse for those two kinds of merchandize, not of Hindostan only, but of all the neighbouring kingdoms, and even of Europe. I have been sometimes amazed at the vast quantity of cotton cloths of every sort, fine and coarse, white and coloured, which the Dutch alone export to different places, especially to Japan and Europe. The English, the Portuguese, and the native merchants, deal also in these articles to a considerable extent."

The first importation of raw cotton from the East Indies into England did not take place until the year 1798, and it was not even then imported by the chartered company, but by privileged merchants. The first cargo of this material which was brought to London was valued in India at £10,000, and it cleared the large sum of £50,000, having been sold at 2*s*. 2*d*. per lb. During the following year the price fell to 10*d*.; and the cotton of India is now the lowest priced that is brought to the English market. It can at present be purchased at 6¾*d*. to 7½*d*. per lb., while the best cotton from Georgia commands from 1*s*. 4½*d*. to 1*s*. 6*d*. per lb. Notwithstanding this very low price of East India cotton, a considerable quantity is still annually shipped to this country, where, in 1832, more than 35,000,000 lbs. were retained for home consumption.

During the late war, when it was the policy of the French ruler to render his country independent of foreign commerce, efforts were made by him to introduce the cultivation of cotton into Italy, Corsica, and some of the southern parts of France. The attempt was attended by partial success as long as other supplies were cut off; but as soon as the cessation of warfare happily restored freedom to commerce, the culture of cotton was gradually abandoned, since the product obtained could not at all compete with that of foreign growth, as regarded either price or quality.

The part of Italy where the cultivation of cotton was most successful was the kingdom of Naples, particularly in that fine plain which extends between Mount Vesuvius, the sea, and the Tifate mountains by Castellamare. Here a new and important trade was created, and carried on successfully as long as the continental system was in force, chiefly by French and Swiss merchants, who had establishments for the purpose at the neighbouring towns of La Torre dell'Annunziata and La Torre del Greco. These establishments closed with the coercive system that had produced them, and generally to the ruin of those who had largely engaged in them. Some small quantities of cotton are still produced there; but of late years it has only been used in the very limited manufactories of the Neapolitan kingdom, and not exported.

An eminent spinner of Manchester, in the year 1824, imported a small quantity of this Neapolitan cotton by way of experiment. The defect, as compared with the American cotton, was the shortness of its fibres. During the eruption of Vesuvius in 1822, some of these cotton grounds suffered much, from being covered to the depth of twelve or fifteen inches by a dry impalpable powder ejected by the volcano.

The Neapolitan cotton was known in commerce by the name of cotton of Castellamare. The agriculturists of the kingdom had also begun to cultivate cotton in some districts of Apulia, under very favourable circumstances of soil and climate, but had made no great progress when the system of Bonaparte fell. In 1824 all these Apulian cotton grounds bore wheat and Indian corn.

About the commencement of the present century the cultivation of the cotton plant had been introduced with success into the southern parts of Spain, by Mr Kirkpatrick, while acting as consul for the United States of America at Malaga. The environs of the village of Churriana, at the foot of La Sierra de Mijas, which before had been an uncultivated waste, was converted by him into a flourishing cotton plantation. Success in this apparently unpromising situation caused the cultivation of the plant to be quickly extended from Motril to Almeira, along the coast of the Mediterranean sea; and the pursuit has become at once a beneficial employment for native industry, and a source of considerable foreign commerce.

When the French armies occupied the southern parts of Spain, in 1810, the exportation of cotton was so considerable as to lead the French government to suspect that the whole of that which went under the name of Spanish cotton was not the produce of Spain. Orders were therefore received by the military authorities to institute inquiries concerning the cotton plantations at Malaga, and to ascertain the quantity which these actually furnished.

Restricted in the exportation of his produce, the indefatigable Kirkpatrick transferred his energies to the erection of spinning factories, and 3,000 workmen were soon employed in a village,

which only a few years before had been a miserable hamlet. But popular commotions, and the occupation by hostile troops, were not favourable to the continued prosperity of the peaceful arts; and so soon as the French troops had evacuated this part of Spain, the prejudiced populace, either instigated by a blind fury, or more probably incited by the agents of those who criminally indulged in political animosities, not only destroyed the factories, but even tore up the cotton plants, and thus, to all appearance, entirely dried up the source of prosperity to a place which had only existed from the profitable employment furnished by this branch of industry.

Notwithstanding, however, its apparently total destruction, the cultivation of cotton had been found too advantageous to be altogether abandoned by those persons who had formerly prospered through its means; and as soon as the opportunity was offered by returning tranquillity, plantations again flourished on the coast of Granada, cotton being now produced in abundance, and of excellent quality, at Motril and through the surrounding country.

The Herbaceous Cotton Plant (gossypium herbaceum) is the only species cultivated in Europe, and is the kind most generally cultivated in other countries also. It is an annual plant, and grows to the height of about twenty inches. The stem is smooth; the leaves with five round lobes, and glandular beneath. The flower is composed of large yellow petals, with a purple centre. The pod is about the size of a walnut; and when mature the external covering bursts, and displays the soft downy fibres of the cotton. This species is supposed to be a native of Persia, and is grown extensively throughout Asia Minor, some parts of America, and in the Mediterranean islands. In the Levant it is sown, in well prepared land, in March, in lines about three feet apart, and the patches of seeds two feet distant in the lines. The plants when they come up are thinned out to two or three in one place, and the earth is stirred up by a one-horse plough, or by manual labour with hoes, and irrigated once or twice a week by directing the water along the furrows between the rows. The flowering season is generally over about the middle of September, and then the ends of the shoots are picked off to determine the sap to the capsules. These are collected by the hand as they ripen, a tedious process, which lasts till the end of November. The cotton is then separated from the seeds, also by the hand; the former is packed in bales for the market; the latter are bruised, and an oil extracted from them. In the Levant the seeds are also used as food.

151.

a b

a Barbadoes Cotton ; *b* Herbaceous.

152.

Cotton Flower and Pod.

The Barbadoes, or Indian Cotton (g. Barbadense). The herbaceous stem rises to the height of ten or twelve feet. The leaves grow upon long hairy foot-stalks, and are divided into deep lobes, the lower leaves having five, and the upper generally three lobes. This plant is a native of India, from whence it was transplanted to the West India islands, where it is extensively raised.

In Barbadoes, according to Mr Long, this plant is sown, in rows about five feet asunder, at the end of September, or the beginning of October, at first but slightly covered, but after the plant springs up, the root is well moulded. The soil should not be stiff nor shallow, as this plant has a tap root. The ground is then hoed frequently, and kept very free of weeds, until the young plants rise to a moderate height. It grows from four to six feet in height, and produces two crops annually; the first in eight months from the time of sowing the seed; the second within four months after the first, and the produce of each plant is reckoned about one pound weight. The branches are pruned and trimmed after the first gathering; and if the growth is over luxuriant, pruning should be practised earlier. When great part of the pods are expanded, the wool is picked, and afterwards cleaned from the seeds by a machine called a gin, composed of two or three

smooth wooden rollers, of about an inch diameter, ranged horizontally, close and parallel to each other in a frame; at each extremity they are toothed or channelled longitudinally, corresponding one with the other; and the central roller being moved with a treddle or foot-lathe, resembling that of a knife-grinder, makes the other two revolve in contrary directions. The cotton is laid, in small quantities at a time, upon these rollers whilst they are in motion, and readily pressing between them, drops into a sack placed underneath to receive it, leaving the seeds which are too large to pass with it behind. The cotton thus separated from the seeds is afterwards hand-picked and cleansed thoroughly from any little particles of the pods or other substances which may be adhering to it. It is then stowed in large bags, where it is well trod down that it may be close and compact, each bag containing 300 lbs. An acre may be expected to produce from 240 to 300 lbs. of cotton.

The Tree Cotton (g. arboreum). This, as the name implies, assumes the form of a tree, and reaches the height of fifteen to twenty feet if left unpruned. The leaves are five-lobed, spear-shaped, and grow on hairy petioles. It is a native of India, and probably the same as seen by Marco Polo at Guizerat. "Cotton," says this observant traveller, "is produced here in large quantities from a tree that is about six yards in height, and bears during twenty years; but the cotton taken from trees of that age is not adapted for spinning, but only for quilting."

The Vine-leaved Cotton (g. vitifolium). In this species the leaves resemble those of the vine. This is also indigenous to the East Indies, and is the kind chiefly cultivated at the Mauritius.

The Hairy Cotton (g. hirsutum). The stalk is herbaceous, with lateral branches, about three feet in height, and covered with a thick down. The upper leaves are undivided and cordate; the lower divided into three and sometimes five lobes, and covered with hair. This plant is biennial, and in warm situations even perennial. It is said to be indigenous to South America, and is occasionally grown in the West Indies.

The Spotted-barked Cotton (g. religiosum). The bark and petioles of this shrub are spotted with black; the leaves are three and five lobed.

The Silk Cotton Tree (g. bombyx ceita). This is one of the tallest of oriental trees. Its stem is of a reddish colour, and hairy or prickly. The leaves are palmate, divided into five lobes. The flowers are first white, then they change to rose colour, and finally become red. Lamarck supposes this tree was indigenous to the lower latitudes of America. The wood is very light, and not much valued except for the construction of canoes. The trunk is very large, and when hollowed out makes canoes capable of containing from fifteen to twenty hogsheads of sugar, of from 6 to 12 cwt. each. When sawn into boards and well saturated with lime water, it bears exposure to the weather for many years. It is also formed into laths for roofs and other domestic purposes in the West Indies. The seed capsule contains a down of a coarser quality than the other cottons.

This tree is cultivated in the Mauritius, where there are two varieties, one producing a white, and the other a yellowish brown cotton. A cotton of this colour is also cultivated in China, and forms the cloth called Nankin.

These are a few of what are perhaps distinct species. The varieties of the cotton plant are, however, exceedingly numerous. Dr Rohr, an extensive cultivator of cotton in the island of St Croix, who paid much attention to the subject, enumerates upwards of thirty species; and Mr Bennet, a cultivator in Tobago, remarked more than one hundred varieties. Dr Rohr considers the different forms of the seeds as distinctive of the different kinds of plants, and classifies them accordingly. Others again consider the distinctive difference to reside in the shape of the seed-pod, the number of its divisions, or the manner and time in which the cotton is retained in its place after the bursting of the pod; while others believe the only circumstances worthy of attention in the classification to be those which regard the staple or fibre.

Very white cotton is not considered the best; a slightly yellow tinge, when not the effect of accidental moisture or of an inclement season, is indicative of greater fineness.

The number of seeds in one pod vary according to the different species; the pods of some containing only ten or twelve seeds, others as many as thirty; while in all there is a marked difference in colour, shape, and size.

The shrub which grows wild in many parts of the West Indies, especially in low and marshy grounds, has a rough black seed. The cotton of this is in colour a pale red, and is of so short a fibre that it cannot be spun; in consequence, it is scarcely worth the trouble of gathering, and what little is picked up is used for stuffing mattresses and pillows. Among other varieties, the Brazil and the Guiana cottons bear the same kind of seed as the wild species, differing slightly in shape; these are both nearly alike as to the quality of their produce. The Guiana is, after the "Sea Island cotton," the most esteemed in Europe, on account of its colour and fineness, and the length and strength of its staple and fibre; it is likewise extremely productive, as it furnishes two gatherings in the year. It is farther valuable, as the seeds of this kind conglomerate, or adhere firmly to each other in the pod, and are easily separated from the cotton. This variety requires a moist soil, such as generally predominates in Dutch Guiana.

The Indian cotton has a dark brown seed streaked with black; this cotton is very white, and finer than that of Guiana, but not so productive. Six other varieties bear nearly the same description of seed, among which is the Siam, so noted in the West Indies as being nearly equal to silk in beauty and fineness. It is of a brilliant whiteness, and its fibres are very fine, long, and elastic. This variety produces twice in the year, but does not bear a great quantity. It is not much cultivated, because it cannot be cleansed without extreme difficulty; the seed being entirely covered with a kind of green moss or hair, cannot be separated from the cotton by any machine, and not even by the hand without much labour and care.

The cotton of Curaçoa and that of St Domingo have small seeds, the surface of which is thinly covered with a few short hairs or a thin beard. This kind is of a very tolerable quality.

The seeds of the Jamaica cotton are perfectly smooth, but so brittle as to break in the process of separating them from their downy envelope. The fibre is coarse but strong; and this would be considered of a very useful quality if it could be better cleansed. Little or scarcely any cotton is at present grown in Jamaica compared to the quantity which was produced there a few years back; but it was always considered as one of the worst cottons in the English market, in consequence of the planters' persisting in the cultivation of a species which could not, without hand labour, be properly divested of its seed; it was always exported mixed with pieces of these, and was therefore known by the technical term *foul* cotton.

Of all the species of cotton the annual herbaceous plant yields the most valuable produce. The "Sea Island cotton," imported into England from Georgia, bears a price double to that imported from any other country. The Persian cotton has long been celebrated for its superior quality; and the concurrent testimonies of many travellers show, that where this species is cultivated in other parts of the globe it is equally excellent. But the additional labour and consequent expense attendant on its cultivation, as well as its not being equally adapted to all soils, afford perhaps sufficient reasons why it is not more generally adopted. This species is cultivated in China, but not in sufficient quantities for the home consumption, as they import this article largely from India.

The quantity of cotton which each plant yields is as various as its quality. Accordingly, there are scarcely two concurrent opinions to be collected on this subject. The average produce per English acre is reckoned by different writers at various quantities, varying from one hundred and fifty to two hundred and seventy pounds of picked cotton.

The cotton plant will grow in most situations and soils, and is cultivated with very little trouble or expense. According to Humboldt the larger species, which attain to the magnitude of trees, require a mean annual temperature of 68° Fahr.; the shrubby kind may be cultivated with success under a mean temperature of 60° to 64°, and may therefore be propagated as far as latitude 40°. This plant is indeed cultivated in the neighbourhood of Astracan, the latitude of which is 46°. Some species flourish best in the neighbourhood of the sea; others again are injured by this proximity. The Pernambuco cotton, which is the finest in Brazil, is of the latter kind, and the planters find that in proportion as they recede from the coast the quality of the cotton is improved; they are, in consequence, every year penetrating more into the interior, and they always obtain a ready market for their produce, as the dealers follow their footsteps, and settle where they settle.

Open situations and a strong soil moderately dry and warm are most congenial to some species, while others thrive better in a moist and deep soil.

In selecting seed for a plantation, therefore, care should be used to adapt it to the soil and situation in which it is to be cultivated. Previously to sowing them the seeds should be wholly divested of every particle of cotton fibre, and then steeped in water during some hours; they are afterwards rolled in sand or any light earth, in order entirely to separate them from each other. This process is considered very much to accelerate their germination. The time for sowing in the West Indies is usually from May to September, both months inclusive. The ground is well prepared and manured, and then holes are made some inches deep and about three feet apart from each other. Eight or ten seeds are generally dropped in each hole, because some of them are liable to be destroyed by a grub or worm, and others to rot in the ground; besides which, a superfluity of plants is required to replace the ravages which are sometimes committed by caterpillars on the tender shoots. The seeds being covered with earth, it is generally expected, and especially if there have been any rain to hasten the germination, that the plants will begin to make their appearance in about eight days. In some situations, when the weather has been very dry, a much longer time elapses. At about the end of six weeks the ground is carefully weeded, and those plants which are the weakest are drawn out, only two or three being left in each hole. When the plants are about three or four months old they are again cleaned and thinned, and the stems and branches are pruned, or, as it is called, *topped*, an inch, or more, of the plants being broken off from the end of each shoot. Occasionally some of the

lower leaves are also taken off. These cares from time to time should be continued till the period of flowering. The time of the seeds coming to maturity varies according to the climate and the species of the plant. When the season has been favourable, the cotton is generally fit for pulling about seven or eight months after it has been sown. This period is, however, well indicated by the spontaneous bursting of the capsule or seed-pod. The plantations at this time are said to present a very pleasing appearance. The glossy dark green leaves finely contrast with the white globular forms profusely scattered over the plant. In the East the produce is gathered by taking off the whole of the pod. In other parts, and this is the more general practice, the seeds and cotton are taken away, leaving the empty husks. The first is, of course, much the most expeditious method, but it has a very serious disadvantage. The outer part breaks in minute pieces, and thus mixes with the cotton, which cannot be freed from it without much time and difficulty.

Whichever method is pursued, this work is always performed in the morning before sunrise, as soon as possible after the cotton displays itself; because long exposure to the sun injures its colour, by giving it a yellow tinge. The pods likewise, which are ready for gathering expand in the heat of the day, and in some varieties the seed and its envelope are then detached from the pod, and falling to the ground the cotton becomes soiled and deteriorated.

In some countries the plant after yielding its produce is every year cut even with the ground; in others this operation is performed only once in two or three years.

The cotton shrub does not in general last more than five or six years in full or productive bearing; the plantation is therefore generally after that period renewed. The seeds may usually be preserved for one or two years, but in some varieties they should be planted almost as soon as they are gathered. The surplus seeds serve as food for cattle; an oil is likewise expressed from them which is employed for many domestic purposes. Although the extraction of oil from the cotton seeds has been long practised in the Levant, it is not many years since these seeds were turned to similar advantage in America.

"Not many years ago," says a recent traveller, "those who had cotton gins felt themselves obliged by any neighbour who was willing to take the seed away; and what might have produced millions of dollars, has been rejected as of no value."

A machine has been invented for *pulling* the seed, that is, separating the external skin, and adhering fibres of cotton from the kernel. After the seeds are pulled, they are ground and pressed in a mill similar to the Dutch oil mills. The expressed oil is then refined, and it answers all the purposes of the best sperm oil. The refuse or oil cake forms a nutritious food for cattle. In this way a considerable quantity of excellent oil, and about forty bushels of cake is obtained from the seeds of a quantity of pods that furnish four bags of cotton.

The annual plant is cultivated in the same manner as that just described; only that in sowing it more seeds are put into the holes, and these are placed nearer to each other. It comes to maturity much quicker, the seeds being sown in April or May, and the crop reaped in September; in some hot climates two harvests can be gathered in each year.

Another important consideration is, that the cotton should not be pulled immediately after rain, as this would render the drying process much more tedious and difficult; and should it retain any moisture when it is packed, it would ferment or become mouldy.

Immediately after gathering it is taken to a barn and assorted according to its quality; it is then laid on mats or hurdles, and exposed to the heat of the sun, or dried in stoves.

The separation of the cotton from the seeds is a very long and troublesome operation, when performed by the hand; for the fibres of the cotton adhere tenaciously to the seed, and some time is consumed in cleansing even a small weight of so light a material. In the greater part of India the use of machinery for this purpose is unknown, and all the cotton is picked by hand. A man can in this manner separate from the seeds scarcely more than one pound of cotton in a day. In some parts of India, however, they make use of a machine, which, though more simple, does not materially differ from the gin used in the West Indies. Dr Buchanan describes it in a Journey from Madras through the countries of Mysore, Canara, and Malabar. Mr Clarke Abel also found precisely the same machine in China, at the village of Ta-tung, not far from Nankin, which he thus describes: "It consisted of two wooden cylinders placed horizontally one above the other, on a stand a few feet from the ground. The cylinders, very nearly touching, were put in motion by a wheel acted upon by the foot. The cotton being brought to one side of the crevice intervening between them during their revolution, was turned over to the opposite; whilst the seeds, being too large to enter, fell at the feet of the workmen." Mr Clarke Abel then describes the instrument used by the Chinese for freeing the cotton from knots and dirt: "This is equally simple, and is the same as that used, I believe, in most countries for the same or a similar purpose. It is a very elastic bow with a tight string. In using it the carder places it in a heap of the material, and having pulled down the string with some force, he sud-

denly allows the bow to recoil; the vibration of the string scatters the cotton about, and separates it into fibres freed from all knots and impurities." A drawing of an instrument scarcely at all differing from this Chinese cotton bow, is given by Sonnerat, in his Voyage aux Indes Orientales, tom. i. p. 108. Thunberg says, that in Batavia, he saw "the cotton cleansed from the seed, by being laid out on extended cloths, and beaten with sticks, till all the seed was perfectly separated from it." The use of the machine called a gin, which we have already described, very much facilitates the process; and by its means one person may separate and cleanse sixty-five pounds per day, and thus, by the use of a simple piece of machinery, increase his effective power sixty-five times. A still greater increase may be obtained by the employment of more complex engines. In the United States of America mills are constructed on a large scale, and are impelled by horses, steam, or other power. Eight or nine hundred pounds of cotton are cleansed in a day by one of these machines, which requires the attendance of very few persons. The American mills are exactly on the same principle as the smaller ones, but are more complete in their appointments. A description of one of the larger sort will therefore comprise all the requisite details of a cotton gin. It consists of two wooden rollers of about an inch in diameter; these are placed horizontally, parallel, and touching each other. Over them is fixed a sort of comb, having iron teeth two inches long and seven-eighths of an inch apart. This comb is of the same length as the rollers, and so placed that its teeth come nearly in contact with them. When the machine is set in motion the rollers are made to revolve with great rapidity in opposite directions, so that the cotton being laid upon them it is by their motion drawn in between the two, whilst no space is left for the seeds to pass with it. To detach these from the fibres of cotton in which they are enveloped, the same machinery which impels the rollers gives to the toothed instrument above a quick wagging motion to and fro, by means of which the pods of cotton as they are cast upon the rollers are torn open, just as they are beginning to be drawn in; the seeds now released from the coating which had encircled them fly off like sparks to the right and left, while the cotton itself passes between the cylinders. The sharp iron teeth of the comb moving with great velocity, sometimes break the seeds; then the minute pieces are instantly hurried on, and pass between the rollers with the cotton. These stray particles are afterwards separated by hand, a process which is called *moting*. Entirely to cleanse the cotton from any remaining fragment of seed it is subjected to another process. This consists in whisking it about in a light wheel through which a current of air is made to pass. As it is tossed out of this winnowing machine it is gathered up and conveyed to the packing house, where, by means of screws, it is forced into bags, each, when filled, weighing about 300 pounds. These are then sewed up and sent to the place of shipment, where they are again pressed and reduced to half their original size.

Some manufacturers fancy that this wholesale machine tears and injures the fibres of the cotton, but it is perhaps an idle prejudice, since the best cotton which we import is from Georgia, where it is most expeditiously cleansed; and that which obtains the least price comes from the East Indies, where the hand is the only machine used.

Another description of gin, called a saw gin, is likewise used for short staple cotton in the United States and in Brazil. This consists of one roller nine inches in diameter, having a series of circular saws fixed upon it parallel to each other, and at a distance of one inch and a half apart. Above this roller is a hopper, having the bottom formed of a grating of wire work, through which the teeth of the saw project to a certain depth. In this hopper the cotton to be cleaned is placed, and, as the cylinder revolves, the projecting teeth of the saw come in contact with the cotton, and drag it through the wire bottom of the hopper, which being inclined at a considerable angle, the seeds, as they are disengaged, roll down, and are conveyed away through a spout in the machine.

The cotton is more quickly cleansed by this method than by the use of the cylinder gin, but at the same time it tears and injures the staple. It is usual in the Liverpool Price Currents to denote, as saw-ginned cotton, the cotton of Brazil cleansed by this process, which fetches a lower price in the market than the Brazil cotton not so operated upon.

Before the invention of spinning machinery in 1787, the demand for cotton wool in England was comparatively small. In the seventeenth century we obtained our trifling supply wholly from Smyrna and Cyprus. In 1786–7 we imported 19,900,000 lbs., viz.: 5,800,000 lbs. from the British West Indies, 9,100,000 lbs. from the French, Spanish, Portuguese, and Dutch colonies, and 5,000,000 lbs. from Smyrna and the rest of Turkey. Shortly after that memorable period in the history of our national manufactures, the annual consumption of cotton increased six-fold, and it has been progressively augmenting ever since.

The average annual import for the six preceding years has been 777,372 packages, each bale weighing about 2½ or 3 cwt. Some few packages come from South America of smaller weight.

From all corners of the world does this raw material flow in upon us, and with expedition

scarcely credible is converted into textures which are reconveyed to the countries of production.

The value of cotton goods exported from Great Britain during four years, stands thus:

	Piece Goods.	Yarn or Twist.
1828	£13,649,012	£3,595,405
1829	13,558,132	3,976,874
1830	15,294,923	4,133,741
1831	13,282,185	3,975,019

All these are real mercantile values. The official value at the custom house is nominal and invariable.

In 1792 the official value of cottons exported was	£1,892,329
In 1830	37,269,432

The quantity of manufactured cottons exported to the East Indies alone in 1828, stood thus:

	Yards.	Value.
To the East India Company's territories, Ceylon, and China.	37,566,836	£1,394,681
To the East India islands, Sumatra, &c.	4,680,370	153,238

Besides which there was exported the following quantity of cotton twist, or spun yarn:

	lbs. weight.	Value.
To the East India Company's territories, Ceylon, and China.	4,549,219	£390,344
To the East India islands, Sumatra, &c.	37,836	2,790

The celerity with which the raw material is converted into cloth by the aid of modern machinery is truly wonderful. The proprietor of a cotton factory in Manchester, having obtained an order for the shipment of some goods of a particular description, purchased ten bales of cotton of suitable quality in Liverpool. On their arrival in Manchester, they were received into the highest floor of his works, and thence proceeding regularly downwards, underwent all the intermediate processes of carding, spinning, and weaving until, in ten days from their reception, the finished goods into which they were converted were packed in bales, and proceeding again to Liverpool for shipment.

When, in 1787, spinning machinery was first erected, one pound of Demerara cotton could be spun into yarn one hundred and sixty miles in length; since that period great improvements have been made in this machinery, and yarn is now spun having a still greater degree of fineness.

Hemp *(cannabis sativa)*. Natural family *urticeæ; diœcia, pentandria*, Linnæus. This is an annual herbaceous plant, rising generally to the height of six feet in ordinary soils; but in a deep rich soil attaining a much greater height. According to Du Hamel, in some parts of Alsace the plant grows to the height of twelve feet, and the stem at the lower part being three inches in diameter. In some parts of Italy it has been found eighteen feet in height.

The stalk is hollow, and contains inside a white, soft, medullary matter, inclosed in a very tender tube, chiefly composed of a cellular texture; and of a portion of longitudinal fibres, commonly

153.

Hemp.

called the reed or boon of the hemp. The bark is rough and hairy, of a green colour, and composed of a number of fibres which extend longitudinally the whole length of the stem. These are not reticulated, but are placed parallel to each other, and united by the cellular texture. When viewed with a microscope, each of these fibres are seen to be made up of bundles of other fibrils, which are twisted spirally, and which, after the process of maceration, can be drawn out and lengthened considerably. The leaves grow out in pairs, opposite each other, on petioles, accompanied by stipules or leaflets. The leaves are divided into four, five, or more deep lobes, which are pointed and deeply serrated on the margins. The upper sides are dark green, the under of a lighter hue; they are rough and furrowed above, and ridged underneath. The male and female flowers grow upon separate plants. In general, the male plants are more slender and delicate than the female, and have also finer and more elastic fibres, composing the bark. The stem grows up single, till near its top, where it divides into several branches, which terminate in thin pointed spikes. In the female the stem is surmounted by tufts of leaves of a considerable size, which readily distinguish it from the male plant. The male flowers grow near the top of the stem in clusters, each cluster bearing nine or ten flowers. The fruit grows in great abundance on the stem of the female hemp. The seed is not preceded by any corolla; a membranous hairy calyx, terminating in long points incloses the pistils, the base of which becomes the seed. The male plant is quicker in its growth than the female, and generally rises half a foot higher, by which provision of nature the farina from the stamina is readily diffused on the pistil

of the lower female plant. The seeds which have grown on the same stalk produce both male and female plants indiscriminately, and the difference cannot be known until the plants are somewhat advanced in growth. When the seed is put into the ground it is therefore quite uncertain what proportion there will be of each; yet here too we have occasion to mark the admirable arrangements of nature, for the due proportion of each generally make their appearance. The seeds are sown about the end of April. The male plants are usually pulled about the beginning of July, and the female in a month or five weeks after, when they have ripened their seeds.

A rich moist soil is most favourable for the full growth of hemp; but it will grow on any soil if well manured, except on a stiff clay, where it does not thrive well. A poor light soil yields but a small return, although the quality is fine; while a strong rich soil yields abundantly, but the quality is inferior.

The fibre of hemp produces a cloth much stronger than that of flax; but its principal use is for the manufacture of cordage, for which its great tenacity particularly adapts it.

The seeds yield by expression an oil, which the Russians use in their cookery, and which painters employ in this country. The seeds are reckoned also a good and nutritious food for poultry, and are supposed to increase the number of hen's eggs. Small birds are in general very fond of them; but they must be given to caged birds with caution, and mixed with other seeds, else they prove too stimulating. The bullfinches and goldfinches by feeding on hemp seed, change the red of their plumage to a black.

The leaves of hemp possess a strong narcotic quality, and they form the basis of the well known Turkish intoxicating drug called *bang*, or *haschisch.*

There is little doubt that hemp was indigenous in Europe. We have records of its growth here for nearly two thousand five hundred years. Herodotus (book iv. 74) says "Hemp grows in the country of the Scythians, which, except in the thickness and height of the stalk, very much resembles flax; in the qualities mentioned, however, the hemp is much superior. It grows in a natural state, and is also cultivated. The Thracians make clothing of it very like linen cloth; nor could any person, without being very well acquainted with the substance, say whether this clothing is made of hemp or flax. A person who has never seen hempen cloth, would certainly suppose that this, of which I am speaking, is made of flax." The Scythians of Herodotus lived in Europe, north of the Danube, and bordering on the Black sea.

The shirts worn by the peasants in the greatest part of Russia, are made of hempen cloth; and they wear very large full breeches of the same coarse material.

The hemp plant was well known to the Romans as a material for cordage in the time of Pliny. This naturalist describes its culture and the preparation to which it was subjected, in order to obtain its fibres, classing these in two different qualities. The filaments nearest to the outer bark and to the reed were considered inferior to those growing in the middle, and were distinguished by the name of *mesa.* But in consequence of their supposed greater liability to be damaged by exposure to moisture, hempen cords, and particularly cables, were not so highly esteemed at that time as were those made from spartium, which were thought to be better qualified for resisting the injurious action of water.

Pliny eulogizes the root, juice, and other parts of this plant, as possessing wonderful medicinal virtues, for which it appears to have obtained a higher value in those days than for its excellent adaptation to the manufacture of cordage, an application at present considered so important as to cause its other properties to be almost entirely disregarded.

Hemp is grown in Persia, Egypt, and various parts of the East Indies; in Africa, in the United States of America, in Canada, and Nova Scotia. Marco Polo mentions that hemp and flax, as well as great quantities of cotton, were cultivated in his time in the neighbourhood of Kashgar in the lesser Bucharia, and in the province of Khoten in Chinese Tartary. According to Mr Clarke Abel, in China proper, though the *Xing-ma (Sida tiliæfolia)* is preferred for cordage, the *Gĕ ma (Cannabis sativa*, or hemp) is also cultivated and manufactured into ropes. At Tungchow, that distinguished naturalist saw the *sida* and *cannabis* growing together, the first in long ridges or in fields like the millet, the second in small patches.

Dampier was told that the Spaniards at Leon in South America, near the Pacific ocean, made cordage of hemp, but he saw no manufactory. Thunberg, on a journey from the Cape of Good Hope into the interior of Africa, found the Hottentots cultivating hemp. "This is a plant," says he, "universally used in this country, though for a purpose very different from that to which it is applied by the industrious Europeans. The Hottentot loves nothing so well as tobacco, and with no other thing can he be so easily enticed into servitude; but for smoking he finds tobacco not sufficiently strong, and therefore mixes it with hemp chopped very fine."

Hemp is cultivated in Great Britain and Ireland, but not very abundantly. The counties of England in which it is principally grown are, Suffolk, Yorkshire, Somersetshire, and the fens of Lincolnshire; in Norfolk and Dorsetshire some few hemp grounds are likewise to be seen.

Hemp is likewise raised in various parts of France, Spain, Denmark, and Sweden, in Wallachia and Moldavia, and in several of the Italian states; but with the exception of Italy, which affords a trifling export, and of Wallachia and Moldavia that supply the Turkish fleet with cordage, none of these countries produce it in sufficient abundance for their own consumption. Among the Italian states the kingdom of Naples is very productive of this useful vegetable substance.

A very considerable quantity is grown in the Terra di Lavora and the districts in the immediate neighbourhood of the capital of that kingdom. In 1827 there were many fields of immense extent lying a little in the rear of the swampy shore, that extends between the mouth of the river Volturnus and Cape Misenum, devoted to this produce. On account of the very disagreeable effluvia proceeding from the hemp while macerating, and from an idea that it is noxious both to the water and the atmosphere, the Neapolitan government has appointed the Lago d'Adnano (a small lake beautifully situated, about a mile in circumference, and between three and four miles from the city of Naples) for this purpose; nor are the growers allowed to steep their hemp in any other place. Those who happen to raise the plant in thinly inhabited places where there is water at hand, as near the swampy shore we have mentioned, put it through the process of maceration on the spot; but the prohibition by law extends to all places within a circuit of many miles, except the Lago d'Agnano. To reach that lake the greater part of the hemp has to pass through the city of Naples, and as the cars on which it is transported are of great magnitude, and many streets of the capital are narrow, and all of them crowded, the cars are not permitted to enter the town until one or two hours after midnight. Every person who has resided at Naples during the summer must have been made sensible of the very considerable quantity of hemp grown in the neighbourhood, by seeing, day after day, the long lines of cars laden with it stationed at three of the four great avenues to the city waiting the appointed hour; and by having his rest broken night after night by the rumbling noise made by these numerous and heavy vehicles as they roll over the lava-paved streets of the town towards the grotto of Posilippo and the lake. In the long subterranean road or tunnel of Posilippo, through which also they must of necessity pass, there being no other communication, the noise they make is astounding. What with going and returning after the hemp has been macerated, the inhabitants of a considerable part of the city of Naples are regaled with this nocturnal music for more than two months every year.*

* Library of Useful Knowledge.

The grand mart however for hemp, as an article of commerce, is Russia, where it is grown in immense quantities, and of the best quality. The principal places of its cultivation are in the southern and western provinces bordering upon Poland, and in the provinces of Poland which belong to Russia. The plants even grow wild in some parts of Russia. In Siberia and about the river Volga it is found flourishing in natural vigour near spots where towns have formerly stood. The Cossack and Tartar women gather it in considerable quantities in autumn, when it has shed its seed and begins to die away. It is not, however, collected by them for its fibres, but is used, as by some other eastern people, as an article of food, for which it is prepared in various ways.*

Much anxiety was evinced some years since in this country that we should obtain supplies of hemp from our own dependencies, and its cultivation was very much encouraged in Canada. The attention of the planters being strongly called to it, several samples of hemp of Canadian growth were sent home. These were placed under the examination of the best judges, by whom they were considered defective, rather from the faulty mode of preparation than from any inferiority in the material itself. Some was found to be of as great a length as the Italian hemp, which is longer than that from the Baltic, but the whole was mixed together without any regard to length or quality. The Petersburgh hemp, on the contrary, is always carefully assorted into different classes, distinguished in commerce as "Clean, or best staple hemp," "best shot," which is rather inferior to the first; and "half clean," which is much inferior. These classes of course obtain very different prices in the market. It was supposed that the Canadian planters would have readily attained to better methods of preparing and assorting, but they have not yet been able to compete with the Russian cultivators, who still exclusively supply our market. At the latter end of the last century, in consequence of our extensive warfare, the importation of this article into England very much increased. For the five years ending with 1776, the average annual quantity was 246,573 cwt.; in the same number of years ending with 1799, the annual average is found to be more than double that quantity, being 573,358 cwt. It is calculated that the sails and cordage of a first rate man-of-war require 180,000 lbs. of rough hemp for their construction.

From the Annals of Agriculture, it appears that in the year 1785 the quantity of hemp exported from Petersburgh to England alone, amounted to 353,900 cwt.; and assuming that it requires five acres of ground to produce a ton of

* Pallas' Travels.

hemp, the whole space of ground requisite for raising the above quantity would amount to 88,475 acres. Since that period it has been much more extensively grown in Russia. In 1799 about 600,000 cwt. were exported in British ships from St Petersburgh.

Riga also exports hemp and flax in large quantities. Hemp and hemp seed, the produce both of Poland and Russia, are carried thither on the river Dwina, and warehoused or shipped at once for foreign ports, according to circumstances. Persons sworn to that office sort the hemp according to its different qualities, and regular prices are fixed before it is brought into the market. It generally arrives at Riga about the middle of May. Polish hemp is, for many purposes, preferred to Russian, being softer, and of a more tender nature. Riga also exports some hemp grown in Livonia, which, though inferior to the best Polish and best Russian, is sometimes valuable to the exporter, as it is carried by land, and is sure to arrive, whereas that brought by water is liable to be detained beyond time by the freezing of the Dwina.

"The bringing together the produce of such an extent of country at the mart of Riga," observes an intelligent traveller, "is well worthy of attention. The produce of Poland from Kieve northward, around the shores of the Dwina, are sent to this place. After the operation of thrashing the different grain is performed, and the frost set in, so that the ice on the rivers will bear, the peasantry are engaged in constructing the raft which is to float these cargoes to their destined port. These vessels are formed with much ingenuity and little expense, being put together without the use of a nail, and merely pegged with wooden pegs, and stuffed with tow *(made from hemp)* to make them impervious to the water. They carry from 200 to 500 tons burden, and are from 200 to 400 feet in length, being formed of large trees split into rough boards. The rudder is a single fir tree, at which ten or twenty men preside, according to the strength required. The most valuable part of the cargo, which is wheat, hemp seed, &c., is stowed in the centre of the vessel, a space being left around the sides for the package of those goods which a little wet will not materially injure, such as hemp, hempen cordage, &c. This being completed, the vessel is ready to take advantage of the earliest part of the navigable season. As soon as the ice is broken up and clear, the vessel floats with the strong current which succeeds to the removal of the ice, and thirty or forty of the peasants, sometimes with their wives and families, take their passage upon it. The owner or his steward meets the cargo at Riga, where it is either sold to the merchants or warehoused. The vessel then is knocked to pieces, and sold for firing, or frequently for paling for the merchants' yards, and often fetches no more than from 100 to 200 rubles." *

Sir Joseph Banks remarks on this subject, that "coarse hemp, such as is required for the manufacture of cables, hawsers, and other heavy rigging, requires every where an abundance of manure and land of the richest quality." The richest of the new moist lands in the south of Italy will bear hemp two, and sometimes even three years, without manure, but they are then much impoverished, and require it.

In Lincolnshire, where strong and heavy hemp is grown, the hemp gardens are small, and near the houses of the growers. These gardens absorb vast quantities of manure, and produce hemp every year, without any alternation of crop, or any change except that in years when the hemp is pulled early a few turnips are sown for a stubble crop.

In Russia the same mode of cultivating hemp on small patches of land, near the houses of the growers prevails, from the facility of getting manure upon it.

When the hemp is required for cordage, it should be sown in drills, as a stronger and coarser fibre will be produced.

When it is wanted for purposes of weaving, then broad-cast is the best method, as the stems rise more slender and fine in proportion to their proximity, provided they are not so near to each other as to choke and impede the growth. There should never be a smaller interval than a foot between each plant.

Three bushels of seed is the ordinary allowance for an acre, when sown broad-cast, this quantity being more or less, according to circumstances. If sown in drills, a bushel and a half is found sufficient.

When the seed is sown it is carefully covered with earth, either by means of a harrow or rake. But, notwithstanding this precaution, it is requisite to keep a constant watch over the ground, to prevent the devastations of the feathered tribe, which, if left unmolested, would make sad havoc among the newly sown grain. The seeds rise up out of the ground with their green shoots in the manner of French beans or lupins, and the birds, mistaking these for perfect seeds, tear them away with the young plants adhering to them; thus the hopes of the planter may be destroyed as soon as they have sprung forth.

The farmers endeavour to frighten away these depredators with scarecrows, as well as by the clamour of children, who are set to watch the grounds. But these precautions are often found insufficient, and the superior vigilance of men or dogs is required effectually to prevent the mischief. Fortunately the irksome occupation

* Journey from Riga to the Crimea, by M. Holderness. London, 1823.

is but of short duration, for as soon as the hemp has put forth a few leaves, it is no longer in danger from the attacks of its former assailants.

After this period, the hemp ground requires very little care or labour till it is fit for pulling. This plant is never overrun with weeds, but on the contrary, has the remarkable property of destroying their vegetation. The cause of its producing this effect is attributed by some cultivators to a peculiar poisonous quality residing in its roots; by others it is considered to be so great an impoverisher of the soil as to draw off all the nourishment, which would otherwise contribute to the growth of weeds.

Agriculturists sometimes take advantage of this well known fact, and by sowing a crop or two of hemp on the rankest soils, they subdue all noxious weeds, and entirely cleanse the ground from these troublesome intruders. One of the greatest difficulties attending the clearing a tract of ground in the vicinity of Naples, the swamp near the Lago di Patria, was to rid it of an exuberant growth of *canne*, or reeds, that rose considerably above the head of a man on horseback. The sowing of hemp was found to be by far the most efficacious means. After hemp, Indian corn was very successfully sown in some of the fields.

It is said that this plant has likewise the peculiar property of destroying caterpillars and other insects which prey upon vegetables; it is therefore very usual, in those countries where hemp is much cultivated, for the peasantry to secure their vegetable gardens from insects, by encircling the beds with a border of hemp, which in this manner proves a most efficient barrier against all such depredators.

The male hemp is known to be ripe by the flowers fading, the farina falling, and the stems turning partially yellow. It is the frequent practice to pull these before they are quite ripe, for after having arrived at their full maturity, the fibres adhere so tenaciously to the reed as not to be readily separated without injury. The Suffolk cultivators gather both male and female plants at the same time, reserving a small part for seed. In Lincolnshire and on the Continent they gather the male plant a month earlier than the female, and therefore small paths are made at intervals through the field, in order that the persons employed may pluck the plants which are ripe without trampling down those which are to remain.

The ripeness of the female hemp is known by the same indications as that of the male, and also by the calyx partially opening and its seed beginning to change colour. They are both less injured by pulling too soon than too late, but when very young, though the fibres are more flexile and fine, the ropes which are made with them are found not to be so lasting as when the plants are gathered in a more matured state.

Hemp is never suffered to remain ungathered, till the seed is perfectly ripe, as at this period the bark becomes woody, and so coarse that no subsequent process can reduce its fibres to a proper degree of fineness. Some plants should therefore be preserved for seed. These require no particular cultivation, but the male hemp is likewise left rather longer than usual that it may attain to maturity and shed its farina upon the seed-bearing plant. The most careful cultivators, however, generally plant out a piece of ground for the purpose of raising seed, as it proves much more prolific when the plants are set at a greater distance from each other.

This has been fully ascertained by the experiments of M. Aimen, who found that forty plants raised in the common way yielded only a pound and a half of seed, whereas from a single plant which grew by itself seven pounds and a half were obtained.

When the hemp is pulled it is taken up by the roots, and before the plants are taken from the field, the leaves and flowers, and sometimes the roots, are taken off with a wooden sword; these are left on the ground, as they greatly contribute to enrich it for the succeeding crop. The stalks are then arranged as nearly as possible in equal lengths, the root ends being laid all on the same side of each handful or bundle, which is then tied round with one of the stalks.

When the hemp is gathered from which seed is to be preserved, it is exposed eight or ten days to the air, after which the heads are cut off, and the seed is thrashed and separated in the same manner as lintseed.

The processes to which the hemp is subjected before it is rendered marketable, and in a state fit for spinning, are very similar to those practised with flax. The same end is required to be attained, that of separating and cleansing the fibres from the woody and gummy matters which adhere to it, and the means used are therefore the same,—the time and degree of each operation being proportionate to the different nature of the two fibres.

The plant is generally dried previously to being watered, but this is objected to by some of the most intelligent cultivators. Mills, in his work on husbandry, gives some very excellent reasons for dissenting from the general practice; he observes, "Those that are for drying it first, say that the hemp thereby becomes stronger than when it is steeped, without having been previously dried. For my part, I confess that this drying seems to be a needless trouble; for as it is necessary in the steeping of hemp that a certain degree of putrefaction should arise sufficient to destroy the texture of that glutinous substance which connects the fibres to the woody

part of the hemp, it certainly is advisable to lay the hemp in water as soon as can be after it is pulled, because the more there is of the natural moisture left in this glutinous substance the sooner the putrefaction would begin. If either by design or by accident the hemp has been dried, the putrefaction comes on more slowly and unequably, and the fibres contract a hardness which the steeping will not afterwards easily correct."

Marcandier is of the same opinion as the writer just quoted, and farther adds, that hemp newly gathered requires only four days' immersion in water, but if it has been previously dried, eight or ten days will scarcely suffice to produce a similar effect, and if the water be hard or of a very cold temperature, a fortnight or three weeks may be found necessary.

Mere exposure to the air is sometimes substituted for the water steeping; this is called dew-retting. The hemp to be so treated is stacked and covered during the first part of the winter, and in January and February is spread upon meadow land and whitened with the frost and snow. The fibres of the plants thus treated are, however, always much inferior to those which are retted by water, and they are fit only for the coarser yarns.

In the cold regions of some part of Russia and Sweden the snow which falls so abundantly is made the means of separating the fibres from the useless part of the plant. The hemp previously dried instead of being steeped in water, is, after the first fall of snow, spread on the ground to receive a fresh accession of snow upon its surface; and this, when dissolved in the spring, leaves the hemp in such a state that the fibres are readily disengaged. In some parts of Livonia a more complicated method is pursued, which it is said enhances the value of the hemp twenty-five or thirty per cent.

A spot where there is a fall of clear water is selected, and five or six basins of about two feet deep are made, one beneath the other; they are divided by slight banks of clay, and communicate with each other by means of a small aperture in each, which can be stopped at pleasure. The plants are steeped in the lowest basin for two or three days, and so on successively to the highest; the first basin as soon as emptied always being filled again with fresh plants; at each time these are supplied, the water is renewed in the top basin, and the apertures being unclosed, an exchange of water takes place throughout all the vessels.

It has always been supposed that some improvement might be introduced in this preliminary part of the preparation of hemp. M. Brulles, an old curate of the department of the Somme, influenced by this opinion, occupied himself for several years with various experiments on the subject. Encouraged by his government, he at length, in 1803, discovered a much superior method, and offered it to the inspection of those interested in promoting the improvement. Napoleon, in the midst of his ambitious schemes and stupendous projects, still gave his attention to this minute point of domestic advantage, and directed that trials should be made of M. Brulles' plan, under the superintendence of Berthollet and other scientific and competent persons. These experiments were carefully pursued for six months, and the result proved highly satisfactory.

The process is wholly different to the usual water-retting wherein so much time is consumed, and in which a situation near a river is almost indispensably necessary for the supply of the canals with soft water. This is M. Brulles' process: soft soap being dissolved in water it is heated to nearly boiling temperature; the hemp stalks are then entirely immersed in this soapy mixture, the plants and fluids bearing the relative proportion in weight of 148 to 650; the boiler containing the whole is then closed, and the fire extinguished. After being subjected to this maceration for only two hours, the hemp is taken out and covered with a layer of straw, that it may cool gradually without losing its humidity.

As soon as one parcel of plants is taken out of the cauldron, fresh ones are put into the same water, care being taken to add a quantity of the soapy mixture equal to that which had been absorbed by the preceding plants.

By then crushing and beating the fibres, they were found to separate more readily than after the common method of retting, and with much less waste, producing in the proportion of four ounces from one pound of plants, while in the ordinary way only three ounces were obtained. On the other hand, the utensils required, and the soap and fuel consumed, might be adduced as countervailing objections, which, however, were believed not only by the inventor, but by those who investigated the method, to be more than compensated by the great advantages attendant on this process.

After watering or macerating the hemp, it is sometimes dried in the same manner as flax, but this operation is more usually hastened by means of an oven or kiln. In this case the heat must be very carefully applied, as too great a degree will injure the fibres by drying up the oil which they contain, leaving them harsh and brittle. Combustion is so easily excited in dry hemp, that when a kiln is employed, great care is taken that no fuel is used which can blaze or sparkle; coke is therefore considered most proper for the purpose.

The drying place is sometimes a kind of cavern, so situated as to be sheltered from the north and north-east winds, and open to the south, that it

may receive the full benefit of the sun. About four feet above the floor, bars of wood are fixed across this cavern, on which the hemp is laid six inches thick. Under the hemp so placed, a small fire is kindled, which is usually fed by the fragments of the reeds of plants, which have been already peeled; this is tended by a careful person, who must always be on the alert to replenish the fire, for the fuel used quickly consumes, and a constant and regular heat should be kept up in the cavern or oven, while very great caution is required to prevent the flame from reaching the hemp. During the process this is turned from time to time, that it may be equally dried throughout.

After it is dried the hemp is usually broken by the hand-break or by mills; when the former is used it is reckoned that one woman can break twenty or thirty pounds during the day. Some cultivators adopt another method for separating the fibres. This is done by simply breaking off a piece of the stalk at the lower end, and peeling the bark from the reed in ribands. It is so simple of performance, that the children, the aged, and the infirm, can be advantageously employed in the task; and where there is a large family, and some hands which would be otherwise useless, this method may be pursued with a good result, but it would be very unprofitable work for an active labourer. Besides which it is not as effectual as the use of the break in separating the fibres. The peeled hemp comes off with much of the useless membranes adhering, and it is not disengaged from any of the dirt, which it may have contracted in the stagnant pools where it has been watered; these circumstances render the after processes with the peeled hemp more difficult than with that which is broken.

The Abbé Brulles recommends another manner of accomplishing the same thing, and which he terms reeding the plant. For this purpose a trough is provided, twelve or fourteen inches deep, and somewhat longer than the hemp under process; to this trough are fitted two pieces of wood, a foot in length, set on one side with brass-wire teeth. The trough being filled with water, and the hemp laid evenly along, these pieces of wood are placed over the hemp, one at the end and the other in the middle of the stalks, serving thus the double purpose of keeping them straight, and of retaining them in the water.

Immediately that the hemp is found to be sufficiently macerated, it is transferred to the trough without any previous drying; there it is gently rubbed, to promote still farther the separation of the bark from the reed. The bark is then disengaged from the stem at the root end; keeping the hand and the reed under water, and laying hold of the stem, it is readily drawn out from the bark, like a sword from its scabbard. In this way a skilful operator may draw out six or more reeds at once. Should any of the reeds be broken, then the board is taken off at the upper end, and the remaining pieces are drawn out at that side.

When the fibres are thus freed from the reeds they are readily disengaged from the remaining parts, now macerated into a jelly, which is removed by washing and rubbing, care being taken not to twist or displace the threads.

After the fibres have been disengaged by either of the foregoing methods, the operation of scutching commences; this has been already described. The usual allowance for waste in Russian hemp, under this process, is estimated at four pounds per hundred weight. A good workman can scutch from sixty to eighty pounds of hemp per diem. Those fibrous parts which are beaten out are carefully collected and scutched separately, and the smaller pieces which are shaken out from the coarse tow used for caulking ships, making flambeaux, mops, and various other articles.

Before the hemp is heckled it is usually made to undergo a previous operation called beetling. This is performed by beating it with heavy wooden mallets, in order still more completely to separate the fibres, and to make them finer and softer. The motion is given to the mallets either by hand or by water, or by other motive power. When a machine is used, the hemp is constantly turned by a boy, in order to change the surface, that every part in turn may receive the strokes. It is then consigned into the heckle.

The heckles used for hemp are somewhat coarser than those for flax. The teeth of the coarsest are usually about an inch in circumference at bottom, diminishing gradually to a sharp point, and they are set about two inches apart from each other.

The produce of an acre of land sown with this plant usually averages from four to five hundred weight of cleansed hemp, and from sixteen to twenty-four bushels of seed. The culture of hemp is considered to be very profitable, and many attempts have been made to encourage its farther growth in England; but a great prejudice formerly existed against this crop, and it was supposed to exhaust the land to such a degree, that many landowners inserted in the leases granted to their tenants, covenants prohibiting its cultivation.

Hemp is admitted from all countries under a nominal duty of one penny per cwt.; its present price, varying according to its quality, is from £21 to £28 per ton.

The Nettle *(urtica.)* This genus, belonging to the same natural family as hemp, also affords a fibre tenacious enough to be manufactured into cloth. The *urtica dioica* grows a weed in almost every region of the globe. This species, as well as *u. urens* and *pilulifera*, have the singular property of being furnished with a poisonous juice.

The small prickles with which the leaves are covered, are hollow tubes filled with an acrid liquid. These tubes have a small hole at the point, and when gently pressed the sharp points enter the skin, and the fluid flows into the wound, causing a burning sensation in the skin, and a blister. A strong decoction of the plant salted, will readily coagulate milk without imparting the disagreeable flavour that ill prepared runnet is apt to do. The Chinese and other nations manufacture a sort of cloth from the prepared fibres of the nettle.

Sunn, or Indian Hemp *(crotoleria juncea)*. Natural family *leguminosæ; diadelphia, decandria*, Linnæus. Two species of *crotoleria* are cultivated in the Indies, and used for the same purposes as hemp. The stalk is herbaceous, furrowed, and grows to the height of four to six feet. The leaves are simple, lanceolate, subsessile; the flowers are papilionaceous; the pods smooth. It is of easy culture, and very productive. The seeds are sown pretty thick, in a soil which requires little previous culture, about the commencement of the rainy season. In about three or four months afterwards the plants are ready for gathering, which is known by the blossoms beginning to fall off. The plants are either pulled up by the roots, or cut down short. They are then immediately placed in shallow water, standing on their root ends, not more than one-third of the plant being immersed; next day they are wholly covered with water; and thus the thicker and more woody part is steeped longer than the thinner and more delicate. After three or four days' maceration, the dresser, standing in the water, takes up a handful of the stems, breaks them in the middle, and strikes each part successively on the water until the fibre separates from the reed. The filaments are then hung up to dry, and with little more preparation are made into cordage, fishing nets, and small lines.

Paat, or *Jute (corchorus olitorius)*. Natural family *siliaceæ; polyandria, monogynia*, Linnæus. This is an annual plant, which flowers in autumn, and grows wild in many districts of India. In Bengal it is cultivated for its fibres, which are made into cordage. In its wild state it is short and branchy; but when cultivated it sends up a smooth round stem, of the height of three feet. About Aleppo the Jews cultivate this plant as a pot herb. The Hindoos also boil and eat the leaves. The stems require to be macerated for two or three weeks before the fibres can be separated. The bags in which Indian sugar is brought to this country are made of the material of this plant.

Chinese Hemp (corchorus capsularis). This species is cultivated in China, as well as in Bengal, both as an article of food and for the manufacture of cordage. It is found, however, to be inferior in every respect to the fibre of hemp.

Another plant, *sanseviera zylanica*, found in China, Ceylon, and other parts of India, is cultivated for similar purposes. Its leaves, which are from three to four feet in length, afford a fibrous substance, which the natives prepare by placing the leaf on a smooth broad table, holding it down by putting their great toe on one end of it, and then scraping it with a thin piece of hard wood held in both hands. Forty pounds of leaves thus scraped will afford one pound of clean dry fibres. Dr Roxburgh reckons this material of excellent quality; and thinks that the China grass, used by the Chinese for fiddle strings, fishing lines, and other purposes, is nothing else than this plant. It is used also by the natives of the Circars for stringing their bows.

Another species, *sanseviera guineansis*, found wild in great abundance in western Africa, is said to rival the New Zealand flax in tenacity of fibre.

New Zealand Flax *(phormium tenax)*. Natural family *asphodeleæ; hexandria, monogynia*,

154.

New Zealand Flax.

Linnæus. This plant, which grows in great abundance in New Zealand, has long slender leaves, resembling the common flag, and which, proceeding from the root, encircle the stem. This latter rises single to the height of several feet, and then branching out, bears a number of small flowers.

The fibrous part of the leaves is possessed of great tenacity and strength, and with very little preparatory labour, is converted by the natives of New Zealand into clothing and cordage, which latter is found to be much stronger than that made from hemp. Another preparation produces from the same plant long slender fibres of a beautiful whiteness, and having the lustre of silk. Of these the natives make their best clothes. This plant was introduced into Ireland by Mr Underwood, in the year 1798, where it has been cultivated as an ornamental plant ever since,

It thrives well in the climate of Britain in the open air, and in almost any situation.

Mr Salisbury, of the Botanic Garden of Chelsea, gives, as the result of his experiments and observations, many useful hints for its culture and preparation. He found that plants of three years old will, on an average, yield thirty-six leaves, besides a very considerable increase of offsets, which leaves being cut down in the autumn, others spring up anew in the ensuing summer. Six leaves have produced one ounce of dry available fibres, having been previously scutched and cleansed; at which rate an acre of land cropped with these plants, growing at three feet distance from each other, will yield rather more than sixteen hundred weight per acre, a great produce compared with that of either flax or hemp. It has likewise the farther advantage of being cleansed with very little labour or trouble. The leaves are cut when full grown, and macerated for a few days in stagnant water; they are then passed under a roller machine properly weighted. By these means the fibres separate, and if then washed in a running stream will instantly become white.

Two or three years back some of this material, which had been obtained from the Colonial Office, was woven into cloth by the pauper children of St George's workhouse, Little Chelsea. It was soft to the touch, and of a good colour. From other trials, however, which have been made, it is supposed that this material does not produce very durable cloth, and that it is not well adapted to the purpose of weaving; but every test has proved its superiority for the formation of cordage.

The leaves of this plant grow in Ireland to five, six, and even eight feet high. It is propagated by offsets, which should not be parted till the parent root is four years old. May is the most favourable season for this work of husbandry.

Experiments have likewise been made at Portsmouth in the application of another product of New Zealand to the manufacture of large and small ropes. A favourable report has been given of the result of these trials. The new material is a strong pliable grass, very silky in its nature, and of very rapid and luxuriant growth, three crops being obtained in one year. It may be brought into this country at the estimated price of £8 per ton, which is now about one-fifth of the price of hemp of the best quality.

CHAP. XLII.

TIMBER TREES—THE OAK, ELM, ASH, &c.

The Oak *(quercus)*. Natural family *amentaceæ; monœcia, polyandria*, of Linnæus. The oak, from the remotest antiquity, has obtained a pre-eminence among trees, and has not unjustly been styled the "monarch of the woods." Its great size, noble aspect, long duration, and the strength and durability of its wood, all contribute to enhance its importance. It was held sacred by the Greeks and Romans, and no less so by the ancient Gauls and Britons. The Romans dedicated this tree to Jupiter; and the Roman husbandmen, before they began their harvest, crowned their heads with wreathes of its leaves. The solemn ceremonies of the Druids were held under its shade, their mysteries were connected with it, and cutting the mistletoe from its trunk formed one of their most sacred rites. To modern Britons, as furnishing the materials of their navy, it is held in no less esteem and importance as a national tree.

> Let India boast her plants, nor envy we
> The weeping amber and the balmy tree,
> While by our oaks the precious loads are borne,
> And realms commanded which those trees adorn.*

Of the oak there are a great many species. Three kinds are indigenous to Britain. A considerable number of species, and many varieties, are found in the temperate parts of Europe; and at least fifty species have been discovered in North and South America. Some of these are deciduous, others evergreen; some only attain the height of shrubs, while others rise to magnificent trees. The temperate regions of the globe are most favourable for the growth of the oak. It is not found generally in the torrid zone, unless at considerable elevations, where the atmospheric heat is greatly reduced; and it grows sparingly and stunted in latitudes far north.

The common British Oak (quercus robur). In this well known species the leaves are deciduous; they are oblong, broader at the top than the bottom, having acute notches with obtuse angles. The trunk is knotty, or "gnarled;" the branches thick, tortuous, and numerous. It flowers in spring, the time depending on the temperature of the season, and the situation and soil. We often observe an oak in full leaf, and at the same time another standing near it without any such appearance, owing to the coldness or poverty of the stratum on which it stands, and which would have been unperceived had not the tree shown it. But notwithstanding this, observation and experience teach us that these differences are very inconsiderable, and that the oak, which is most backward in putting forth its leaves, generally retains its verdure the longest in the autumn. In general the flowers, which are of a yellowish hue, begin to open about the 7th of April; about the 18th the leaves appear, at which time the flowers are in full bloom; and about

* Pope.

the 6th of May the leaves will be quite out, and remain until the autumnal frosts come on. When

155.

The Oak.

the oak grows alone it is moderately low, and its branches spreading. In this case the timber is also said to be more compact and stronger, and the crooked arms or branches better suited for ship building. In thickly planted groups the stems grow upwards, and often reach the height of forty to fifty feet without giving off lateral branches, while the branches attain a height equal to that of the trunk, thus forming a tree of 100 feet in height.

The wood of the oak, though full of minute pores, forming to appearance a spungy net-work (see Plate I., fig. 8.), is yet of great strength and durability. Some timber may be harder, some more difficult to rend or tear, and some less capable of being broken across; but none contains all these qualities united in such a superior degree as the oak; hence its great use in ship building, where all these requisites are demanded. The oak is not so much used for ship-building as it was formerly, having been in a great measure superseded by fir, and latterly larch wood has been much employed for this purpose. The sailor will still, however, maintain that his ship is "heart of oak." The seed of the oak, or acorn, is a well-known nut, contained in, and partially covered by, the calyx of the flower. Our rude ancestors are said to have fed on them; and acorns are still used as food by the peasantry in the south of Europe. Cervantes, in his romance of Don Quixote, not only sets them before the goat-herds as a dainty, but picks out the choicest as a dessert for the Countess herself. The oaks with edible acorns are not, however, of the same species as the English oak. The Italian oak, which Virgil represents as the monarch of the forest, and of the elevation of whose top, the stedfastness of whose roots, and of whose triumph in its greenness over the lapse of ages, he gives a splendid description in the second book of his Georgics, bore fruit which was used as food. The *quercus ilex* (the evergreen oak), which is still common in Spain, in Italy, in Greece, in Syria, in the south of France, and on the shores of the Mediterranean, bears a fruit which, in its agreeable flavour, resembles nuts. It is a slow-growing tree, and is always found single, and not in clumps. There is another evergreen oak, *quercus ballota*, very common in Spain and Barbary, of which the acorns are most abundant and nutritive. During the Peninsular war, the French armies were fortunate in finding subsistence upon the ballota acorns in the woods of Salamanca. We are often startled by the assertions of ancient writers, that the acorn, in the early periods of society, formed the principal food of mankind. Much of our surprise would have ceased had we distinguished between the common acorn and that of the ilex, ballota, and esculus oaks. Some of the classic authors speak of the fatness of the primitive inhabitants of Greece and southern Europe, who, living in the forests which were planted by the hand of nature, were supported almost wholly upon the fruit of the oak. The Grecian poets and historians called these people *balanophagi* (eaters of acorns); but then the Greek word *balanos*, which the Romans translated *glans* (acorn), applied also to such fruits as dates, nuts, beech-mast, and olives. These all contain large quantities of oil, which renders them particularly nutritive.

Whether the custom existed among the ancient Britons, or (as is more probable), was imported by the Saxons, who came from the thick oak forests of Germany, it is certain that, during the time when they held sway in this country, the fattening of hogs upon acorns in the forests was accounted so important a branch of domestic economy, that, at about the close of the seventh century, king Ina enacted the *panage laws* for its regulation. The fruit of the oak then formed *gifts* to kings, and part of the dowries of queens. So very important was it, indeed, that the failure of the acorn crop is recorded as one of the principal causes of famine. One of the most vexatious acts of William the Conqueror, in his passion for converting the whole of the forests into hunting grounds, was that of restricting the people from fattening their hogs; and this restriction was one of the grievances which king John was called upon to redress at the triumph of Runnemede, where his assembled subjects compelled him to sign *Magna Charta*. It is to be observed that swine's flesh was the principal food of most nations in the earlier stages of civilization; and this is to be attributed to the extreme rapidity with which the hog species multiply.

Up to a recent period, large droves of hogs were fattened upon the acorns of the New Forest, in Hampshire, under the guidance of swine-herds, who collected the herds together every night by the sound of a horn. At the present time, the

hogs of Estremadura are principally fed upon the acorns of the *ballota* oak; and to this cause is assigned the great delicacy of their flesh.

The history of the importance of the oak as timber nearly keeps pace with that of ship-building; and there is little doubt that, from the time of Alfred, who first gave England a navy capable of contending with her enemies upon the sea, to that of Nelson (about nine hundred years afterwards), in whom nautical skill appears to have been raised to the greatest possible height, the oak was the principal and essential material in ship-building. It is more than probable that the inferiority of some of our more recently built ships, and the ravages which the dry-rot is making among them, have arisen from the substitution of foreign oak for that of native growth. A writer in the Quarterly Review has ascribed this evil to the substitution of a foreign species of oak, in our own plantations, instead of continuing the true native tree.

"We may here notice a fact long known to botanists, but of which our planters and purveyors of timber appear to have had no suspicion, that there are two distinct species of oak in England,* the *quercus robur*, and the *quercus sessiliflora;* the former of which affords a close-grained, firm, solid timber, rarely subject to rot; the other more loose and sappy, very liable to rot, and not half so durable. This difference was noticed so early as the time of Ray; and Martyn, in his *Flora Rustica*, and Sir James Smith, in his *Flora Britannica*, have added their testimonies to the fact. The second species is supposed to have been introduced, some two or three ages ago, from the continent, where the oaks are chiefly of this latter species, especially in the German forests, the timber of which is known to be very worthless. But what is of more importance to us is, that, *de facto*, the impostor abounds, and is propagated vigorously in the New Forest and other parts of Hampshire, in Norfolk, and the northern counties, and about London; and there is but too much reason to believe that the numerous complaints that were heard about our ships being infested with what was called, improperly enough, *dry-rot*, were owing to the introduction of this species of oak into the naval dockyards, where, we understand, the distinction was not even suspected. It may thus be discriminated from the true old English oak: the acorn-stalks of the *robur* are *long*, and its leaves *short;* whereas the *sessiliflora* has the acorn-stalks *short*, and the leaves *long;* the acorns of the former grow singly, or seldom two on the same foot-stalk: those of the latter in clusters of two or three, close to the stem of the branch. We believe the Russian ships of the Baltic, that are not of larch or fir, are built of this species of oak; but if this were not the case, their exposure on the stocks, without cover, to the heat of summer, which, though short, is excessive, and the rifts and chinks, which fill up with ice and snow in the long winter, are enough to destroy the stoutest oak, and quite sufficient to account for their short-lived duration."

* Or rather, the sessiliflora may be reckoned a variety.

The trunk of the detached oak acquires by far the greater diameter; some of the old hollow trees, most of which are of this description, having a diameter of as much as sixteen feet in the cavity, and still a shell of timber on the outside, sufficiently vigorous for producing leaves and even acorns. The age to which the oak can continue to vegetate, even after the core has decayed, has not been fully ascertained; but in favourable situations it must be very considerable. In the New Forest, Evelyn counted, in the sections of some trees, three hundred or four hundred concentric rings, or layers, of wood, each of which must have recorded a year's growth. The same celebrated planter mentions oaks in Dennington Park, near Newbury, once the residence of Chaucer, which could not have arrived at the size which they possessed in a less period than about three hundred years; and though he does not say upon what evidence the opinion is grounded, Gilpin notices, in his Forest Scenery, "a few venerable oaks in the New Forest, that chronicle upon their furrowed trunks ages before the Conquest."

Some out of the number of ancient oaks that are celebrated, it may not be uninteresting to mention. One of the three in Dennington Park, the King's Oak, was fifty feet high before a bough or even a knot appeared, and the base of it squared five feet entirely solid; the Queen's Oak was straight as a line for forty feet, then divided into two immense arms, and the base of it squared to four feet; and Chaucer's oak, said to have been planted by the poet, though inferior to the royal ones, was still a most stately tree. The Framlingham oak (Suffolk), used in the construction of the Royal Sovereign, was four feet nine inches square, and yielded four square beams, each forty-four feet in length. An oak felled at Withy Park (Shropshire), in 1697, was nine feet in diameter without the bark; there were twenty-eight tons of timber in the body alone; and the spread of the top, from bough to bough, was one hundred and forty-four feet. In Holt Forest (Hampshire), there was an oak which, at seven feet from the ground, was thirty-four feet in circumference in 1759, and twenty years after, the circumference had not increased half an inch. Dr Plott mentions an oak at Norbury which was of the enormous circumference of forty-five feet; and when it was felled, and lying flat upon the ground, two horsemen, one on each side the trunk, were concealed from each other. The same author mentions an oak at

Keicot, under the shade of which four thousand three hundred and seventy-four men had sufficient room to stand. The Boddington oak, in the Vale of Gloucester, was fifty-four feet in circumference at the base. The larger arms and branches were gone in 1783; and the hollow cavity was sixteen feet in its largest diameter, with the top formed into a regular dome; while the young twigs on the decayed top had small leaves about the size of those of the hawthorn, and an abundant crop of acorns. The hollow had a door and one window; and little labour might have converted the tree into a commodious and rather a spacious room. The Fairlop oak in Essex, though inferior in dimensions to the last mentioned, was a tree of immense size, being between six and seven feet in diameter at three feet from the ground. Damory's oak in Dorsetshire was one of the largest oaks of which mention is made. Its circumference was sixty-eight feet; and the cavity of it, which was sixteen feet long and twenty feet high, was, about the time of the Commonwealth, used by an old man for the entertainment of travellers, as an ale-house. The dreadful storm in the third year of last century shattered this majestic tree; and in 1755 the last vestiges of it were sold as firewood. An immense oak was dug out of Hatfield bog. It was a hundred and twenty feet in length, twelve in diameter at the base, ten in the middle, and six at the smaller end where broken off.

Dr Hunter, in his notes to Evelyn's Sylva, thus describes the great Cowthorpe oak, near Wetherby, in Yorkshire, as it stood in 1776: "The dimensions are almost incredible. Within three feet of the surface it measures sixteen yards, and close by the ground twenty-six yards, or seventy-eight feet. Its height in its present ruinous state is almost eighty-five feet, and its principal limb extends sixteen yards from the bole. Throughout the whole tree the foliage is extremely thin, so that the anatomy of the ancient branches may be distinctly seen in the height of summer. When compared to this, all other trees are but children of the forest." In 1829 it is again described thus by the Rev. Thomas Jessop: "The Cowthorpe oak is still in existence, though very much decayed. At present it abounds with foliage and acorns; the latter have long stalks, the leaves short ones. The dimensions are as follow: Height forty-five feet; circumference, close to the ground, not including the angles, sixty feet, at one yard high forty-five feet; extent of principal branch fifty feet, being an increase of two feet in about half a century. I am inclined to think that the original dimensions were those given in the Sylva. The oldest persons in the neighbourhood speak of the tree as having been once much higher; and were the angles included in the measurement, which project from the lower trunk, the circumference might be made out twenty-six yards. It is said by the inhabitants of the village, that seventy persons at one time got within the hollow of the trunk; but on inquiring, I found many of these were children; and as the tree is hollow throughout to the top, I suppose they sat on each others' shoulders; yet, without exaggeration, I believe the hollow capable of containing forty men." *

The Greendale oak, in Nottinghamshire, still remains a curious monument of antiquity. In 1724 a road-way was cut through its venerable trunk higher than the entrance to Westminster Abbey, and sufficiently capacious to permit a carriage and four horses to pass through it. The circumference of the trunk above the arch is thirty-five feet, the height of the arch ten feet, and the circumference about the middle upwards of six feet.

Some oaks have been as celebrated for being the records of historical events, as others have been for their magnitude, although a part of the celebrity may no doubt be fabulous. Not a hundred years ago, the oak in the New Forest, against which the arrow of Sir William Tyrrel glanced before it killed William Rufus, is said to have been standing, though in such a state of decay, that Lord Delaware erected a monument to indicate the spot. The Royal Oak at Boscobell, in which Charles the Second concealed himself after the defeat at Worcester, has disappeared; and though several trees were raised from its acorns, the race seems now to be lost to vegetable history. An oak of still more venerable pretensions now stands, or lately stood, at Torwood Wood, in Stirlingshire, under the shadow of which the Scottish patriot Wallace is reported to have convened his followers, and impressed upon them not only the necessity of delivering their country from the thraldom of Edward, but their power of doing it, if they were so determined. Gilpin mentions one more ancient even than this—Alfred's oak at Oxford, which was a sapling when that great monarch founded the university. This cannot, of course, be implicitly credited; but still the very mention of such things proves, that the oak can reach an age several times exceeding that of the longest lived of the human race.

Oaks are generally raised in quantities together, forming woods, either sown by the operations of nature, or planted by art. The plants are raised from seed, and either allowed to grow up in the spots where they have originally sprung, or they are first reared in nurseries, and then transplanted. Some diversity of opinion exists as to which of these methods is the best, although it is generally allowed that the best oak wood is

* Strutt's Sylva Britannica.

produced from natural growth, or which nearly resembles this, seed planting.

For raising the seeds in the nursery, a good fresh loamy soil is selected. Having prepared the beds, the acorns, which should also be well selected, and taken from the finest trees, are to be sown about three inches apart, and covered over with the soil. This operation is best performed in February, though some prefer the autumnal months. In about six weeks the plants will appear above ground; and in these beds they may remain two years without any further care than keeping them free from weeds. The ground, when they are to be planted out, must be prepared by deep trenching, or ploughing several times. The plants are then pulled up, the tap root cut off, and a sufficient hole being made with a spade, successively placed into the fresh earth, in rows four feet apart. A man and boy will thus plant 1500 to 2000 in a day.

In raising oaks from the seed, the ground is to be prepared in the same manner, and marked out into lines or spaces. The acorns are then deposited about ten inches apart, in a hole made with a dibble, and covered up. This is done in February or March; and care is afterwards taken to keep the ground free from weeds. As the plants come up thinnings are made, and deficiencies supplied as found necessary.

In all cases of planting, shelter and warmth are essentially necessary; and when the aspect is unfriendly, the plantation should be skirted to a sufficient thickness with Scotch firs, mixing some of them also in the body of the wood. In this manner an exposed situation may be made to produce excellent timber; and when the trees are grown to a size sufficient for their own protection, the firs in the centre should be removed, otherwise they will injure the young oaks. On the judicious thinning and clearing of young wood depends much of the planter's success and profit.

The transplanting of large trees seems to have been a circumstance long ago practised. Evelyn thus alludes to it: "*Veterem arborem transplantare*, to transplant an old grove, was said of a difficult enterprise. Yet before we take leave of this subject, let us show what is possible to be effected in this kind with cost and industry. Count Maurice, the late governor of Brazil for the Hollanders, planted a grove near his delicious paradise of Friburgh, containing six hundred cocoa trees of eighty years' growth, and fifty feet high to the nearest bough. These he wafted upon floats and engines four long miles, and planted them so luckily, that they bore abundantly the very first year, as Gasper Barlæus hath related in his elegant description of that prince's expedition. Nor hath this only succeeded in the Indies alone; Monsieur de Fiat, one of the mareschals of France, hath with huge oaks done the like at Fiat. Shall I yet bring you nearer home? A great person in Devon planted oaks as big as twelve oxen could draw, to supply some defect in an avenue to one of his houses, as the Right Honourable the Lord Fitzharding, late treasurer of his Majesty's household, assured me, who had himself likewise practised the removing of great oaks, by a particular address extremely ingenious, and worthy the communication.

"Choose a tree as big as your thigh, remove the earth from about it, cut through all the collateral roots till, with a competent strength, you can enforce it down upon one side, so as to come with your axe at the tap root; cut that off, redress your tree, and so let it stand covered about with the mould you loosened from it, till the next year, or longer if you think good, then take it up at a fit season; it will likely have drawn new tender roots apt to take, and sufficient for the tree wheresoever you shall transplant it. Some are for laying bare the whole root, and then dividing it into four parts, in form of a cross, to cut away the interjacent rootlings, leaving only the cross and master roots that were spared to support the tree; then covering the pit with fresh mould, as above, after a year or two, when it has put forth and furnished the interstices you left between the cross roots with plants of new fibres and tender shoots, you may safely remove the tree itself, so soon as you have loosened and reduced the four decapitated roots, and shortened the tap roots; and this operation is done without stooping or bending the tree at all. And if, in removing it, you preserve as much of the clod about the new roots as possible, it would be much the better.

"Pliny notes it as a common thing to re-establish huge trees that have been blown down, part of their roots torn up, and the body prostrate. To facilitate the removal of such monstrous trees for the adornment of some particular place, or for the rarity of the plant, there is this farther expedient: A little before the hardest frosts surprise you, make a square trench about your tree, at such distance from the stem as you may judge sufficient for the root; dig this of competent depth, so as almost quite to undermine it, by placing blocks and quarters of wood to sustain the earth; this done, cast in as much water as may fill the trench, or at least sufficiently wet it, unless the ground were very moist before. Thus let it stand till some very hard frost do bind it firmly to the roots, and then convey it to the pit prepared for its new station, which you may preserve from freezing by laying store of warm litter in it, and so close the mould the better to the straggling fibres, placing what you take out about your new guest to preserve it in temper. But in case the mould about it be so ponderous as not to be re-

moved by an ordinary force, you may then raise it with a crane, or pulley, hanging between a triangle, made of three strong and tall limbs united at the top, where a pulley is fastened, as the cables are to be under the quarters which bear the earth about the roots, for by this means you may weigh up and place the whole weighty clod upon a trundle, sledge, or other carriage, to be conveyed and replanted where you please, being let down perpendicularly into the place by the help of the foresaid engine. And by this address you may transplant trees of a wonderful stature without the least disorder, and many times without topping, a diminution of the head, which is of great importance where this is practised to supply a defect or remove a curiosity."*

Such are the directions of Evelyn, which lately have been revived and put in practice by Sir J. Stewart of Allanton, and many others.

About sixty years after the time of Evelyn, the "transplanting machine" was invented by Brown, the celebrated landscape-gardener, and the removal of large trees became much more easy. The machine consisted of two very high wheels, an axle, and a pole; and when the trees were large, a truck-wheel was used at the end of the pole. The tree was considerably lopped, the earth loosened from the roots, the pole set erect and lashed to the stem; and then a purchase being made fast to the upper part of the pole, the whole was pulled at once, and drawn horizontally along.

Still, though this machine, and the mode of using it, were great improvements upon the methods recommended by Evelyn, yet the trees were subjected to much mutilation, and they did not recover their beauty and vigour till some time had elapsed.

In the year 1816 a much improved mode of transplanting grown timber was introduced by Sir Henry Stuart of Allanton. By the practice of that mode, he, in the course of five years, and at an expense remarkably moderate, converted his park, from a cold and naked field, to a rich scene of glade and woodland. Sir Henry's success has been so complete, that his example has been followed by many other proprietors in the uplands or central part of the south of Scotland. Generally speaking, that part of the island is remarkably destitute of timber; and as the country is pastured by sheep, which require fences more elevated and also more close than cattle, the rearing of wood, in the common way of planting, is very expensive. The nakedness of that part of Scotland is severely felt in the violence of the winds, which are certainly more tempestuous, and attended by more intense cold, than in some parts of the country much further to the north,—the snows never falling to the same depth, or being accompanied by the same violence on the Grampians in Perthshire, as upon the naked mountains in the counties of Selkirk and Peebles. In this part of the country, therefore, the invention by Sir Henry Stuart is of the utmost value. Nor is its value confined to those districts in which wood is wanted; for there is much in the disposition of trees, not only as respects beauty, but as regards usefulness; and by Sir Henry's plan, growing timber may be moved, at no very great expense, from one place to another, and that without almost the least interruption of its growth.

According to this method, there is no mutilation of the tree—not a branch is lopped off; and at the time of the removal, not a root is broken; the trees are prepared before they are begun to be removed. This preparation consists in cutting all the roots at some distance from the tree. It is well known that such an operation, instead of being hurtful to trees, is often of advantage. When the long lateral roots are cut, the stumps, if they have not been rendered too short, put out a number of young fibres, which appear to draw and convey the nourishment with more effect than those fibres that are connected with the more extended roots.

The most handsome and thriving trees are selected as those that will bear transplantation with the least danger; and the lateral roots being divided, as has been stated, the stumps are covered with fresh mould, in which they are left for two or three years, in order that they may put out new fibres for the absorption of nourishment. This preparation of the tree actually improves it, as the fibres have to fetch the nourishment from a shorter distance. The tree, being thus prepared, can be moved not only without mutilating the top, but also without tearing up the root; and thus the transplanting, if performed with skill, becomes a healthful rather than a dangerous operation. The pits for the reception of the trees are, in the meantime, got ready; and for trees of about thirty feet in height (the diameter of the trunk of such a tree may average about a foot), the diameter of these pits is about eighteen feet. The earth of the pits is trenched to the depth of about two feet; and in the course of the trenching, it is well mixed with compost of a nature as different as possible from that of the soil; and the ground thus prepared is the better if it lie for a year or more, in order that the component parts of the soil may be properly mixed and mellowed. When that has been done, the planting is accomplished by removing the earth to a proper depth, placing the tree in the pit thus made for it, adjusting the roots as nearly as possible to their natural order, and then covering them with earth. This being properly accomplished, the firmness which the trees have is much greater than would at first

* Evelyn's Sylva.

sight be suspected. Though the trees in Allanton park are a good deal exposed to the violence of the winds, yet they do not require to be much propped.

The expense of this system of transplantation is comparatively trifling; and if there be a supply of trees at not too great a distance, there is no question that a park may be ornamented, or land sheltered, by this means, much more cheaply than by any other, and with the incomparable advantage that it is done at once. After the ground has been prepared, the whole expense of removing and replanting the trees is not more than from ten to thirteen shillings each, for trees of from twenty-five to thirty feet in height; about half that sum for smaller ones; and not above two shillings or eighteen pence for shrubs or brushwood. The following is Sir Henry's account of his park, extracted from his "Planter's Guide:"—

"There was in this park originally no water, and scarcely a tree or a bush on the banks and promontories of the present lake and river, for the water partakes of both these characters. During the summer of 1820 the water was introduced; and in that and the following year, the grounds immediately adjoining were abundantly covered with wood by means of the transplanting machine. Groups and single trees, grove and underwood, were introduced in every style of disposition which the subject seemed to admit. Where the turf recedes from, or approaches the water, the ground is somewhat bold and irregular, although without striking features of any sort; yet the profusion of wood, scattered over a surface of moderate limits, in every form and variety, gave it an intricacy and an expression which it had never possessed before.

"By the autumn of the third year only after the execution, namely, 1823, when the Committee of the Highland Society honoured the place with their inspection, the different parts seemed to harmonize with one another, and the intended effects were nearly produced. What it was wished to bring forward appeared already prominent—what was to be concealed or thrown into the back-ground, began to assume that station. The fore-ground trees, the best that could be procured, placed on the eastern bank, above the water, broke it into parts with their spreading branches, and formed combinations which were extremely pleasing. The copse or underwood, which covers an island in the lake, and two promontories, as also an adjoining bank that terminates the distance, was seen coming down nearly to the water's edge. What was the most important of all, both trees and underwood had obtained a full and deep-coloured leaf, and health and vigour were restored to them. In a word, the whole appeared like a spot at least forty years planted."

Of the *quercus robur*, or British oak, three varieties, or perhaps distinct species, are enumerated. The *sessiflora*, sessile-fruited or female oak, has oblong, obtuse, deciduous leaves, which are winged, sinuated, and have very short footstalks, with the acorn growing on long footstalks. The *pedunculata* has oblong, subsessile, smooth, sinuated leaves, with round lobes, and fruit oblong, stalked. The *pubescens* is distinguished by oblong, obovate, sinuated leaves; downy beneath, with obtuse, angular lobes, somewhat heart-shaped, and unequal at the base. The fruit is nearly sessile.

The *pedunculata* is supposed to be the common indigenous oak of England, being much more common in woods than the others. The timber is said to be whitish and hard, while that of the sessile-fruited is reddish and brittle. We shall proceed to enumerate some of the more remarkable species of the oak found in other countries.

Turkey Oak (quercus cerris.) This oak is indigenous to Spain and the south of Europe. The leaves are oblong and pointed, and frequently indented in the middle like a lyre. They are jagged and acute, pointed; a little hoary on their under side, and stand upon slender footstalks. The acorns are small, and have rough prickly cups. Of this species five varieties are enumerated:

The rough-leaved, *bullata*.
Narrow-leaved, *sinuata*.
Lucombe, *exoniensis*.
Fulham, *sempervirens*.
Toothed, *dentata*.

Italian Oak (q. esculus.) This species is found growing naturally in Italy and Spain. The leaves are smooth, and deeply sinuated, like winged leaves; some of the sinuses are obtuse, and others end in acute points; they have very short footstalks, the branches are covered with a purplish bark when young; the acorns are long and slender, the cups rough and a little prickly, sitting close to the branches. These acorns are sweet, and are frequently eaten by the poor in the south of France in times of scarcity, and ground and made into bread along with wheat flour. Of this species of oak the Romans made their civic crowns.

The *Velonian Oak (q. ægilops.)* A native of the Levant and of Spain. The trunk rises nearly as high as the common oak; the branches extend very wide on every side, and are covered with a grayish bark, intermixed with brown spots; the branches are closely garnished with oblong, oval leaves, about three inches long, and almost two broad, which are deeply sawed on their edges; most of the teeth turn backwards, and terminate in acute points. The leaves are stiff, of a pale green on the upper, and downy on the under sides. The acorns have very large, scaly cups, which almost cover them; the scales are ligneous,

and acute pointed, standing out a quarter of an inch; some of the cups are as large as middle sized apples.

The *Evergreen Oak (q. ilex).* The holly, holm, or evergreen oak is a handsome tree, and is common in the south of France and the southern parts of Europe. Of this tree there are several varieties, marked by the size and shape of the leaves; yet Miller has proved that they all spring from the same acorns. Sometimes even the lower leaves of the same tree differ from those on the higher branches. The varieties are:

The common, *integrifolia.*
Notch-leaved, *serrata.*
Long-leaved, *oblonga.*

The leaves of this tree are from three to four inches long, and one broad near the base, gradually lessening to a point: they are of a lucid green on the upper side, but whitish and downy on their under; and are entire, standing upon pretty long footstalks. They remain green during all the year, and do not fall till they are thrust off by the young leaves in the spring. The acorns are smaller than those of the common oak, but of the same shape. The timber is supposed to equal that of the common oak.

The *Kermes Oak (q. coccifera).* This is a common tree all along the Mediterranean coast. It is of small growth, seldom rising above twelve feet; the leaves are oval and undivided. They are smooth on their surface, but indented on their edges, which are armed with prickles like those of the holly. The trunk is feathered to the bottom, which gives it the appearance of a bushy shrub. The acorns are smaller than those of the common oak. From this tree are gathered the kermes, with which the ancients used to dye their garments of that beautiful colour called *coccineus* or *coccus*, being different from the purple of the Phœnicians, which was obtained from the testaceous mollusk, called *murex.* In course of time the murex was neglected, and the kermes of the oak was introduced. This continued in use till the discovery of America introduced the cochineal insect from the *cactus opuntia*, already described. The people of Barbary still employ the kermes for dyeing the round scarlet caps, so much used in the Levant; and they prefer that of Spain to their own growth.

The *Cork Oak (q. suber).* The cork tree rarely exceeds thirty-five to forty feet in height, and from two to three feet in diameter. The leaves are entire, oblong, oval, about two inches long, and one and a quarter broad, with serrated edges, and slightly downy on the under sides: the footstalks are very short. The leaves continue green throughout the winter, till the middle of May, when they generally fall off just before the new leaves come out, so that the trees are very often almost bare for a short time. The acorns are oval, rather large, and of a sweet

156.

Cork Oak.

taste. This tree is found in abundance in Portugal, Spain, Italy, the southern parts of France, and in the Barbary states: Spain and Portugal supply the greater portion of the cork which is used in Europe. The timber of the cork oak is heavy, hard, and compact, but is not so durable as that of the common oak, especially when exposed to water. The outer bark of this tree grows unusually large, and when removed is speedily again renewed by the liber or inner bark. This process, so far from injuring is said to prolong the life of the tree; for when this excess of bark is not artificially removed, the tree seldom lives longer than fifty or sixty years, while the barked trees flourish for upwards of a hundred and fifty years. This barking process is not commenced till the tree is twenty-five years old, and even then the bark is of little value. Ten years after, it is barked a second time; but though this second growth is much better, because less cracked; it is not yet thick enough to make good corks for bottles, and is used principally for fishermen's nets. It is not till after forty-five or fifty years that the bark has all the requisite qualities for making good corks; and from this period a tree is regularly barkéd every eight or ten years.

The months of July and August are those in which the bark is removed. For this purpose two longitudinal incisions are made opposite each other the whole length of the body of the tree; other two incisions are made transversely at the two extremities; the bark is then detached by inserting between it and the wood the handle of the hatchet, which is wedge-shaped. In this operation great care must be taken not to injure the tender laminæ of the epidermis; for were this inner bark destroyed, no further deposition of cork bark would take place.

After having been scraped the bark is cut into pieces, slightly charred to contract the pores and destroy insects, and then pressed flat with stones. In Catalonia it is divided into pieces and boiled in water, which adds to the quality of the cork. Good bark should be elastic and compressible,

neither porous nor ligneous, and from fifteen to twenty lines in thickness. The advantage of this substance for bottle corks is, that it possesses the elasticity necessary to conform exactly to the shape of the neck of the bottle; and also an impermeability of structure, which prevents the contained liquor from being absorbed, and dissipated by evaporation.

According to Michaux, the cork gathered in France is from 17 to 18,000 quintals, each of which gives from 7,000 to 7500 corks 18 lines long, when the sheet is even and smooth. From 110 to 115 millions of corks are annually consumed in France. In the year 1827, 2500 tons of cork bark were imported into Great Britain. Besides being made into corks, it is also manufactured into floats, shoe soles, and other articles. The smoke and charcoal of burning cork collected, forms the substance called Spanish black.

Cork was well known to the ancients. It is mentioned by Theophrastus, Pliny, and other authors, as in use among the Greeks and Romans for floats to fishing nets, buoys to anchors, and several other purposes. During the seige of Rome by the Gauls, when Camillus was sent to the capitol through the Tiber, he had a life preserver of cork under his dress.

The *White Oak (q. alba)*. This is a native of the United States of America, and of parts of Canada. It rises to the height of seventy or eighty feet, by six or seven feet in diameter. The leaves are of a light green, six or seven inches long, and four broad in the middle: they are regularly indented, almost to the midrib; the indentations are obtuse, the footstalks are short. The acorns very much resemble those of the common oak. The bark is of a grayish-white colour, with large black spots. The timber is of a reddish hue, and in strength and durability much resembles that of the British oak; but it is less heavy and compact. The wood is universally used in America for various purposes in the arts. The bark, which is used for tannin, is also said to produce a purple dye.

The exports of this wood which come through Quebec, are chiefly from the borders of Lake Champlain, within the limits of the territory of the United States. Though not so durable for ship-building as the British oak, it has the advantage of a superior elasticity, by which it can be bent in a shorter time into ship timber.

The *Red Oak (q. rubra)*. This species is found in most parts of the North American continent, but flourishes best in the northern states, and in Canada. It is a tall tree, growing to the height of eighty feet. The bark is smooth, and of a grayish colour, but darker on the young branches. The leaves are six inches long, and two and a half broad in the middle; they are obtusely sinuated, each sinus ending with a bristly point; of a bright green colour, with short footstalks. The leaves continue green till late in autumn, and if frost does not set in early, even to Christmas, before which time they change their colour to a red. The acorns are very abundant, large, and contained in very flat cups. The timber is reddish, its texture coarse, and its pores entirely empty; they are sometimes large enough to admit the introduction of a hair. The wood is strong, but is apt to decay soon. It is chiefly used for staves. The bark is also employed in tanning.

Chestnut Oak (q. prinus). Michaux enumerates five species of the chestnut oak. They are so called because the leaves resemble very closely those of the chestnut tree. The largest sort grows in the rich low lands, and attains a considerable height. The wood is small grained, and very serviceable in the arts: the bark is gray and scaly, the leaves six inches long, and two broad, indented on the edges with numerous transverse veins proceeding from the midrib to the margin. They are of a bright green hue. The acorns are large, with short cups. The species are—

The swamp white oak, *discolor*.
Chestnut white oak, *palustris*.
Rock chestnut oak, *monticula*.
Yellow oak, *acuminata*.
Small chestnut oak, *chincapin*.

These oaks are found partially diffused over the middle and northern states of America.

The *Live Oak (q. virens)*. This species is found exclusively in the maritime parts of the

157.

Live Oak.

southern states of Florida, and lower Louisiana. The influence of the sea air seems necessary to its existence; for it is seldom seen to make a part of the forests even at so short a distance as fifteen or twenty miles from the shore. It is most abundant on the islands, and around the bays of the main land. The most common height of this oak is from forty to forty-five feet, with a diameter of from one to two feet. Like all solitary growing trees, this one has a very broad tufted head, borne upon a trunk eighteen or twenty feet high, but which most frequently branches out into several boughs at about half that height;

so that seen from a distance, its appearance is not unlike that of an old apple tree. Its leaves are oval, coriaceous, of a dark green on the upper surface, and whitish underneath. They are several years without falling, and succeed each other but partially. The acorns are of a long oval form, almost black, with shallow cups of a grayish colour, borne on pretty long footstalks. It is said that the Indians formerly extracted an oil from them, which they mixed with their food; and it is not improbable but that they ate them, as they have not the austere taste of most other acorns. In some years these nuts are very plentiful, and they germinate so readily, that if the weather is moist and rainy during the period of their maturity, they begin to shoot out their radicles even while still hanging on the trees. The trunk of this oak is covered with a blackish bark, which is hard and thick. The timber is of a yellowish colour, deeper in old than in young trees, and very heavy and compact. Its texture is fine and close, the annual circles being very near each other, evidently showing the slowness of its growth. Being more durable than the best white oak, it is much esteemed for ship building, and is accordingly in high request in all the harbours of the northern states, where it is regularly imported. Its durability, when kept dry, makes it useful in constructing the upper parts of vessels; while its weight renders it less adapted for the lower parts, unless when accompanied by corresponding pins of red cedar wood, which being light, and susceptible of resisting decay under changes of wet and dry, renders it a suitable accompaniment to the oak.

The small size of the tree does not afford timbers of any great magnitude; but its spreading branches furnish *knees* and other suitable parts for ship building. The consumption of this wood, both in the United States, and for exportation to England, is now very considerable, and has increased much of late years. From this consumption, and the clearing of the islands on which it chiefly grows for the production of cotton, joined to the slow growth and difficulty of raising the live oak, it is fast disappearing from the country.

The Willow Oak (q. phellos). This tree is confined to the middle and southern states of America. It attains the height of fifty to sixty feet, with a diameter of two feet. The bark is smooth and of a thick texture; the leaves from two to three inches long, and narrow and tapering like the common willow; they are of a light green colour and smooth surface. The acorns are small, round, and not abundant on the trees. The willow oak grows in humid situations. The wood is of loose coarse texture, and is not much used.

Of the other species, described by Michaux, we may shortly mention the laurel oak, or swamp willow oak, which attains the height of fifty to sixty feet. Its wood is very valuable, and almost preferable to that of the live oak already described. The water oak, *q. aquatica*, which, when full grown, is about thirty feet high, with leaves varying exceedingly in their form. The downy black oak, *q. triloba*, forty feet high, of very rapid growth, and well suited for enclosures. The barren black oak, or black jack of Virginia, *q. nigra*, of low growth, bearing numerous nuts, which are excellent feeding for hogs. The black, or quercitron oak, *q. tinctoria*, one of the largest of the American oaks, and highly valuable for its timber and bark.

The Dyer's Oak (q. infectoria), is that from which the nut-galls of commerce are procured, although the gall nut is common on almost all the other species of the family. This species is a shrub, seldom exceeding six feet in height, very common in Asia Minor. It was first accurately described by M. Olivier in his Travels, and the shrub itself was introduced by him into France, where it is now cultivated as a garden plant, and grows well in the open air.

The gall is a morbid excrescence produced by the puncture of a winged insect, to which Olivier has given the name of *Diplolepis Gallæ Tinctoriæ*. This excrescence is of a globular form, with an unequal and tuberculous surface. It is developed on the young shoots of the tree, and contains within it the eggs which the insect has deposited. The best galls are gathered before the transformation of the insect, because in that state they are heavier, and contain more of the tannin principle. When the insect has left them, they are pierced from the interior to the surface. The best galls come from Aleppo. The substance of which they are composed is peculiarly astringent; of which, according to Sir Humphry Davy, five hundred parts contain a hundred and eighty parts of soluble matter, principally formed of tannin and gallic acid. One hundred and seventy-four tons of galls were imported into the United Kingdom in 1827.

The instinct by which certain insects choose for the nests of their future offspring the substance of various vegetable bodies, is one of the most curious provisions in the economy of nature. After having pierced those bodies, they deposit their eggs, which, being hatched, produce *larvæ*, that are more or less fatal to the vegetable substance to which they are attached. According to Virey, an irritation is produced by the introduction of these insects, that resembles a tumour and inflammation in an animal body. The cellular tissue swells; the parts, which were naturally long, become round; and the flow of liquid matter produces a change of organization, from which results a complete change in the external form of the organ. In this way is the gall produced. The oak-apple is an excrescence

of the same nature, though effected by a different species of insect. There are various insects possessing the instinct thus to deposit their eggs, that are furnished with an apparatus of the most curious construction, necessary for puncturing the branch, as is done by the parent, and for piercing a way out of the gall, as is done by the insect produced, after it has passed its larva state. Each species of insect chooses not only the particular vegetable, but the part of that vegetable which is best adapted for the reception of its larvæ; and in this way the same plant, for instance the oak, sometimes receives the nests of twenty different species of insects. A gall sometimes contains a single larva, sometimes many, and it is thus either called simple or compound.

"The insect that wounds the leaf of the oak," says Mr Knapp, "and occasions the formation of the gall-nut, and those which are likewise the cause of the apple rising on the sprays of the same tree, and those flower-like leaves on the buds, have performed very different operations, either by the instrument that inflicted the wound, or by the injection of some fluid to influence the action of the parts. That extraordinary hairy excrescence on the wild rose, likewise the result of the wounds of an insect *(cynips rosæ)*, resembles no other nidus required for such creatures that we know of; and these red spines on the leaf of the maple are different again from others. It is useless to inquire into causes of which we probably can obtain no certain results; but, judging by the effects produced by different agents, we must conclude that, as particular birds require and fabricate from age to age very different receptacles for their young, and make choice of dissimilar materials, though each species has the same instruments to effect it, where, generally speaking, no sufficient reasons for such variety of forms and texture is obvious; so is it fitting that insects should be furnished with a variety of powers and means to accomplish their requirements, having wants more urgent, their nests being at times to be so constructed as to resist the influence of seasons, to contain the young for much longer periods, even occasionally to furnish a supply of food, or be a storehouse to afford it when wanted by the infant brood."

According to Reaumur, the cynips is provided with a needle in a sheath, which has most surprising powers of extension, derived from the peculiar construction of the whole body of the insect, so much so that the needle can be extended to double the length of the animal itself; and thus it forms a nest for its offspring, while the young, in the same manner, pierce their way out of the vegetable shell which has been their protection.

Another parasite of a vegetable kind, also frequently found on the oak, and connected with this tree by the mysteries of the Druids, we shall also here describe.

THE MISLETOE *(viscum album)*. *Diœcia, tetrandria*, of Linnæus. This may be considered

158.

The Misletoe.

the only true parasitical plant indigenous to Britain, as at no period of its existence does it derive any nourishment from the soil or from decayed bark, like some of the fungi, &c. It is an evergreen. The branches are numerous and forked, covered with a smooth bark of a yellowish green colour. The leaves are tongue-shaped, entire, in pairs upon very short footstalks. The flowers are male and female in different plants, axillary, and in short close spikes; neither male nor female flowers have a corolla, the parts of fructification spring from the calyx. The fruit is a globular smooth white berry, covered with a viscous substance; these berries appear in winter. The root insinuates its fibres into the woody substance of the tree, and thus derives nourishment from the plant. The whole forms a pendent bush of from two to five feet in diameter. It grows on various trees, chiefly fruit trees, or on the thorn, oak, and maple, ash, or even pines. There is only one species that grows on the oak, though at one time designated by a distinct name, being found identical with the others. It is generally conveyed from tree to tree by birds, which swallow the berries, and pass the seeds undigested. It may also be readily propagated artificially, by introducing the berries into slits in the bark of a suitable tree. By the Druids the misletoe was held sacred, and many virtues were attached to it. They sent round their attendant youths with this plant to announce the entrance of the new year; and a somewhat similar custom is still continued in France. In England, branches of it are hung up in most houses at Christmas, along with other evergreens. Birds feed on the berries, especially

the misletoe thrush. Bird-lime is obtained from the berries and the bark of this plant, as well as from the bark of the common holly, by decoction in water.

The misletoe was formerly esteemed in medicine as a cure for epilepsy and other convulsive diseases; but it is now entirely disused.

THE ELM *(ulmus)*. Natural family *ulmaceæ; pentandria, digynia,* of Linnæus. There are several species of the elm tree, all, bearing so close a resemblance to each other, as to render any distinctive description difficult. It is doubtful whether the most common kinds, the *u. campestris, montana, glabra,* and *fruticosa,* be not but varieties of the same tree. Linnæus considered all the European elms as forming but one species.

159.

The Elm.

The Common Elm (u. campestris), is one of the tallest and finest of European trees. Some of those old elms planted in France by Sully, minister of Henry IV., about the year 1580, yet survive, and reach in height from eighty to ninety feet, with a circumference of twenty-five to thirty feet of spreading branches.

The bark of the elm is smooth in young trees, and very tough, but afterwards it cracks and becomes rough. The leaves are oblong, pointed, doubly serrate, rough, and unequal at the base, with a short foot-stalk. The flowers appear in the beginning of March, about three weeks before the leaves. They are small, of a reddish colour, united in clusters, and spring from the shoots of the preceding year. They are succeeded by oval-bordered capsules, containing a single round compressed seed, which ripens in May. The wood has less strength than that of the oak, and less elasticity than the ash; but it is tougher and less liable to split. The quality of the wood depends much on the soil, high ground and a strong soil being necessary for its perfection. The knobs which grow on old trunks are divided into slips by the cabinet makers, and often exhibit beautiful veins and contortions of the fibres.

The elm appears to be indigenous to Britain, and several other countries in Europe. Not less than forty places in England derive their names from this tree, evidently from remote antiquity, most of them being mentioned in Doomsday book.

The Wych Elm (u. montana). The Wych elm, or Wych hazel, so called from its resemblance to the latter tree, grows wild in some of the northern counties of England. It attains a great size. The bark of the young shoots is smooth, tough, and of a yellowish brown colour, with white shoots. The leaves are oval, six inches long, and about four broad. The flowers grow in clusters towards the end of the twigs; they have long leafy impalements of a green colour, and appear in spring before the leaves. The wood is not reckoned so serviceable as the common elm. Anciently it was made into bows.

The Smooth Elm (u. glabra), is very common in several parts of Hertfordshire, Essex, and other north-east counties of England, where it grows to a large tree, and is much esteemed. The branches spread out like those of the first sort. The leaves are oval, and sharply serrated on the edges. They are smoother than most of the other sorts, and do not appear till the middle or latter end of May.

The Dutch Elm (u. suberosa), is characterized by large thick leaves and a fungous bark. The flowers are also of a light tint, and the seeds large. Its wood is said to be softer than that of the common elm. It was brought from Holland during the reign of king William, and was used in the trim clipt hedges of that period, but is not now much cultivated.

The American Elm (u. Americana). There are two kinds enumerated, the white and the red; the former having a grayish bark, deeply furrowed; the latter a reddish brown. Both rise to the height of noble trees, and their wood is much employed for various domestic purposes.

The elm is propagated by layers, seeds, and grafting. It thrives best in a good soil, and in single trees, or interspersed in hedge-rows, instead of forming large woods.

The elm attains a large size, and lives to a great age. Mention is made of one planted by Henry IV. of France, which was standing at the Luxembourg at the commencement of the French revolution. One at the upper end of Church-lane, Chelsea (said to have been planted by queen Elizabeth), was felled in 1745. It was thirteen feet in circumference at the bottom, and one hundred and ten feet high. Piffe's elm, near the Boddington oak, in the vale of Gloucester, was, in 1783, about eighty feet high, and the smallest girth of the principal trunk was sixteen feet. From the planting of Sir Francis Bacon's elms, in Gray's Inn walks, in 1600, and their decay about 1720, one would be disposed to assign the healthy period of the elm to be about one hundred and twenty years. The health of these must have been, however, affected in some degree by the smoke of London. The superb

avenue, called "The Long Walk," at Windsor, was planted at the beginning of the last century. Most of the trees have evidently passed their prime. The most profitable age of elms, both for quantity and quality of timber, is, probably, about fifty or sixty years. The central parts of a tree get indurated, lose their natural sap, and are apt to absorb moisture, by which they soon rot on exposure to the air, long before the dry rot consumes them, shielded as they are by the external parts. The predominance of resin insoluble in water, and not liable to be acted on by the acids of the atmosphere, is the cause why the pine and the larch are more durable than the silver fir and the spruce. It is possible that the elm is injured by too much humidity in the soil upon which it grows; and that the Dutch elm, which is usually classed as a different species from the common elm, and of which the timber is inferior, may be merely the common one debased in the humid soil of Holland.

The elm rises to a greater height than the generality of English forest trees, with a foliage at once full and hanging loosely, and thus capable of receiving great masses of light, and of producing "the chequered shade," which imparts such a sparkling beauty to woodland scenes.

The elm has been always considered as one of the trees which can be most safely transplanted after attaining considerable size. Evelyn gives several accounts of trees of this species being thus removed into other soils.

The shelter which trees afford to the soil is one of the surest means of increasing the warmth and fertility of a country; and many districts have been converted from bleakness and sterility, to productiveness and value, by plantations of timber. This is particularly the case where the wind blows over those cold surfaces of heath and morass, which occur in the northern parts of the island of Great Britain. The subject has not been investigated with that attention which its importance merits; but appearances render it highly probable that the spawn of *mosses* and *lichens* are wafted by the winds; and that if these winds are not purified from the pestilent spawn, they spread a noxious vegetable growth over what would otherwise be fertile land. In this way belts of plantations act as a sort of filter for the winds. The trees next to a marshy heath have been covered with lichens, so that no part of the bark was visible; while in the interior of the belt, and on the side most distant from the barren track, the bark has been free from these parasites. Further, after the trees have attained sufficient size to shelter the land, the moss has disappeared from it, and the soil has become fit for the production of valuable crops. Nor is it on trees alone that this effect of winds, from cold and watery tracks, may be perceived; for those sides of ancient and elevated buildings which are opposed to them are incrusted with moss and lichen, while the other sides are comparatively clean. To any one who has paid much attention to the more sterile districts of the country, it is matter of every-day notice, that nothing tends so much to confine within bounds the plants which are hostile to the grasses and cultivated crops as timber; and this being the case, it follows that the means of procuring an instantaneous shelter of grown timber are, at the same time, the surest means of procuring, comparatively, instantaneous fertility. In many instances the land, when not sheltered by timber, has returned to its original sterility, whenever it has been allowed to lie in grass; but when so sheltered, the pastures have retained their greenness for years, and, instead of being deteriorated, have been improved by remaining for a few years out of tillage.

The transplantation of grown timber trees appears, indeed, to be the only way by which shelter can be restored to cold, bleak, and exposed districts. The remains of large trees, which are found in the mosses and bogs of such districts, prove that once both the soil and climate have been adapted to the production of wood. This is true not only of those countries where timber is still to be found in warm and sheltered places, but in those dreary climes where now hardly a shrub is to be found, and where, although young timber be planted, it will not grow—as in the counties of Sutherland and Caithness, the Orkney and Shetland isles, and even in Iceland itself. The latitude has not altered since the trees which are found in the peats-bogs of those regions were green and flourishing upon the surface; and if the soil and the climate have been deteriorated, it must have been by exposure to the damp and bleaching winds. Those winds, as has been said, prove fatal to young trees; but it is probable that, if grown timber, of the more hardy sorts, could be introduced as a shelter, the land would recover its former fertility, and the landscape its ancient beauty.

The observations of philosophical travellers and inquirers, with regard to the whole of the northern countries of the world, whether in the eastern continent or the western, confirm these remarks. Sir Hans Sloane, in his account of the bogs of Ireland, mentions that a great part of those districts which are now covered by that unprofitable substance, must have been once clothed with forests of trees. Broke, in his Winter in Lapland and Sweden, notices the same change as having taken place in the north of Lapland and the islands. Sir George Mackenzie and others observe the same as being the case in Iceland; and Hearne mentions that large tracts of the northern parts of America, which at his visit were covered with moss and swamp were forests

in the days of the fathers of the Indians then living. In many parts of the highlands and western islands of Scotland, where there is now hardly a tree, or, at most, only coppice, along the shores of the lochs, or arms of the sea, there are found not only the trunks and roots of trees in the soil of the bogs, but the roots of oaks of large dimensions standing on the surface; nor can the period at which they were growing have been very remote, for, in some of the wild and almost inaccessible glens, many large trunks still lie mouldering and neglected.

THE BEECH *(fagus sylvatica)*. Natural family *amentaceæ; monœcia, polyandria* of Linnæus. The beech is a stately and beautiful tree, attaining a large size. The trunk is massive, and covered with a smooth shining bark, which seldom cracks into fissures; the branches spread out horizontally, thus affording "the cool shade," so often alluded to by the poets. The leaves are rather small, of a soft silken texture, and delicate green colour when young, and becoming harder and darker as they come to maturity. After they have lost their verdure they still adhere to the branches, and thus continue for the greater part of the winter. In this way the trees planted in hedges or other fences afford a good shelter for tender plants.

A variety called the *purple beech*, with foliage of a deep brown or purplish hue, forms a very beautiful and striking contrast among other green foliage. This variety may readily be propagated by engrafting. The *ferruginea* is of a still deeper red, and is common in America.

The buds of the common beech begin to expand about the 15th of April, and the leaves come out about the 21st. The flowers appear about the 12th of May, and by the first week of June they are in full blossom. The mast or seed, which is an angular nut contained in a prickly capsule, is ripe in autumn. This tree thrives best in a chalky or strong soil, the bark upon such soils being clear and smooth, a sign of healthy vigour in the tree. When planted upon strong or chalky cliffs, the beech will resist the winds better than most other trees; and in this case the plants should be taken from a nursery of a similar soil.

The wood is brittle, and not well adapted for those purposes where strength and durability are required. It is, however, well suited for the turning lathe; and beechen bowls seem to have been in early use among the Roman peasantry. The mast is found to be a very nutritious food for swine, and is much used for this purpose.

In North America two species of the beech are common. The white and red beech. The white beech, *f. sylvestris*, is more slender and less branching than the red; but its foliage is superb, and its general appearance magnificent.* The leaves are oval, acuminate, smooth, shining, and bordered in the spring with a soft hairy down. The sexes are borne by different branches on the same tree. The barren flowers are collected in pendulous, globular heads; and the others are small, and of a greenish hue. The perfect wood of this species bears a small proportion to the sap, and frequently occupies only three inches in a trunk, eighteen inches in diameter. Notwithstanding the beauty of this tree, its wood is of little use but for fuel. The red beech, *f. ferruginea*, is almost exclusively confined to the north-eastern parts of the United States; and to the provinces of Canada, New Brunswick, and Nova Scotia. It bears a close resemblance to the common European species. Its wood is stronger, tougher, and more compact than that of the white kind, and is accordingly more useful. It is so liable to the attacks of insects, that its use in domestic furniture is rare. Experience has shown the advantage of felling the beech in summer, while the sap is in full circulation; cut at this season it is very durable, but felled in winter it decays in a few years. The logs are left several months in the shade before they are hewn, care being taken that they do not repose immediately on the ground, after which they are fashioned according to the use to which they are destined, and laid in water for three or four months. They are said to be rendered in this way inaccessible to worms. The beech is very durable when preserved from humidity, and incorruptible when constantly in the water; but it rapidly decays when exposed to alternations of dryness and moisture. When burnt the wood ash affords a large proportion of potass.

* Michaux.

Hedges are frequently constructed of the beech, and when trimmed close afford an excellent shelter, especially in the winter and spring months, in consequence of the old leaves still remaining in a withered state on the stems.

In Belgium, between Ghent and Antwerp, very solid and elegant hedges are made with young beeches, planted seven or eight inches apart, and bent in opposite directions, so as to cross each other and form a trellis, with apertures five or six inches in diameter. During the first year they are bound with osiers at the point of intersection, where they finally become grafted and grow together. As the beech does not suffer in pruning, and sprouts less luxuriantly than most other trees, it is perfectly adapted for this purpose.

The beech is reared easily from the seed, which may be sown at any time between October and February; but the best season is about two weeks after they drop from the tree. In France and Germany an oil is extracted from the beech nut little inferior to olive oil.

The forests in the department of the Oise have yielded in a single season more than two

millions of bushels of these nuts; and in 1779 the forest of Compaigne alone afforded oil sufficient to supply the wants of the district for more than half a century. The nuts are collected in dry weather as they fall from the trees, which, to facilitate this, are shaken by the peasants: the oil is abundant only when the fruit is perfectly ripe. Being thus collected and cleansed by winnowing or in mills, they are spread out on floors like corn, and frequently turned till they are dry. In the winter months they are ground down and formed into a paste; and afterwards this paste is subjected to strong pressure in wool or hair bags, when the oil oozes out and is collected; this process is repeated a second or third time, till all the oil is extracted. By care and skill the quantity of oil thus obtained is equal to one-sixth of the nuts employed. The oil becomes limpid by repeatedly drawing it off the dregs, and at the end of six months arrives at perfection. It will last good for ten years or upwards.

The Hornbeam *(carpinus betulus)*. Natural family *amentaceæ; monœcia, polyandria* of Linnæus. This is sometimes called the horse beech, from its resemblance to the common beech. It is common in England, but is rarely allowed to grow to its full height, being polled by the country people. According to Miller, however, the tree reaches seventy feet in height, with a large round stem, perfectly straight and sound when growing on a stiff clay, which appears to be its natural soil. As this tree then thrives on cold, barren, and exposed hills, and in situations where few other trees will vegetate, it may be cultivated with advantage in such situations. It is by no means of slow growth, and resists the violence of winds better than most other trees; and is thus well adapted as a means of shelter. It should be raised from seeds planted in the spot where it is intended to grow; and these seeds may be sown in autumn, when they will spring up the following spring. Like the beech, the leaves of the hornbeam remain on the branches till the young buds push them off in spring.

The wood is not much esteemed except for fuel. Hedges are constructed of the hornbeam similar to those formed of the beech. They are very common in some parts of Germany.

The *American Hornbeam (c. Americana)*, is common in the States, and in the warmer parts of Canada. The trunk, like that of the European species, is obliquely and irregularly fluted, frequently through all its length. The bark is smooth and spotted with white. The fertile flowers are collected in long, pendulous, leafy aments, at the extremity of the branches; and the scales or leaves which surround them contain at the base a hard oval seed. The fructification is always abundant, and the aments remain attached to the tree long after the foliage is shed. The wood is white and exceedingly compact, and fine grained; but as the timber attains a very limited size, it is fit for no useful purpose.

Iron Wood *(carpinus ostrya)*. This tree belongs to the same natural family and order as the above. It is a native of North America, and grows not in groups, but loosely disseminated in cool, fertile, and shaded situations. The leaves are alternate, oval, acuminate, and finely and unequally serrated. The fertile and barren flowers are borne at the extremity of different branches of the same tree; and the fruit is in clusters like hops, hence the name *ostrya*. The small hard triangular seed is contained in a species of reddish, oval, inflated bladder, covered at the age of maturity with a fine down, which causes a violent irritation of the skin if carelessly handled. In the winter this tree is recognised by a smooth grayish bark finely divided and detached in stripes, not more than a line in breadth. The wood is perfectly white, compact, fine grained, and heavy. The concentric circles are closely compressed, and their number in a trunk of only four or five inches in diameter, evinces the slow growth of the tree.

The wood is so hard as to be used in place of iron levers for splitting trees. In New York brooms and scrubbing brushes are made of it, by shredding the end of a stick of suitable dimensions. If the wood could be procured of larger size, it no doubt might be applied to many useful purposes.

This tree has been transplanted to France, where it flourishes; and it probably might be propagated with advantage in other parts of Europe.

The Ash *(fraxinus excelsior)*. Natural family *aleineæ; polygamia, diœcia* of Linnæus. The ash is indigenous to Britain, and is a well known tree. The stem is covered with a smooth bark, and grows tall and rather slender. The branches are flattened; the leaves have five pairs of lobes, terminated by an odd one of a dark green colour; lanceolate, with serrated edges. The flowers are produced in loose spikes from the sides of the branches, and are succeeded by flat seeds which ripen in autumn. In its period of leafing the ash is very late, being generally towards the end of April, or middle of May. It is also among the first to shed its leaves on the first approaches of the autumnal frosts. The varieties of this species are the *weeping ash (pendula)*, first discovered in a field at Gamblingay, Cambridgeshire. The *yellow barked, (jaspidea)*; the *green coloured, (atrovirens)*. It has been known from the remotest period of history, and it is very generally diffused. It agrees with a greater variety of soil and situation than perhaps any other tree producing timber of equal value; and, differing from many other trees, its value is in-

creased rather than diminished by the rapidity of its growth. On very poor soils, where it grows stunted, it is brittle, and soon affected by the rot; but, where the growth has been vigorous, the compact part of the several layers bears a greater proportion to the spongy, and the timber is very tough, elastic, and durable. In elasticity it is far superior to the oak, and it is not so liable to be broken by a cross strain; but it is much more fibrous, and more easily split. The ash is, by way of eminence, called the "husbandman's tree," nothing being equal to it for agricultural implements, and for all sorts of poles, ladders, long handles, and other purposes which require strength and elasticity combined with comparative lightness.

At all ages the growth of the ash is of value: the thinnings of young plantations, and the suckers that spring up from the roots of grown trees, or from the stools of trees that have been cut down, are excellent for hoops, hop-poles, and every other purpose where clean, light, and strong rods are wanted at small expense. The leaves, and even the twigs, are eaten by cattle with great avidity; the bark is useful in tanning; and the wood yields, when burnt, a considerable quantity of potass.

The drip of the ash is injurious to most other plants, and, therefore, when it is planted in corn-fields, a certain portion round it is unproductive; but, in marshy situations, the roots of it, which run a long way at a considerable depth, act as under-drains. Hence the proverb, in some parts of the country, "May your foot-fall be by the root of an ash,"—may you get a firm footing. Some idea of the change of times and opinions may be formed from the value set upon the ash, in the laws of Howel Dda, wherein, while a branch of misletoe is reckoned at thirty shillings, an ash, not being named, must be classed with "trees after a thorn," and therefore be rated at fourpence! In the useful arts, one good ash is worth all the misletoes that ever grew. Such was the veneration of some of the ancients for the ash, that Hesiod derives his brazen men from it; and the Edda, or sacred book of the North-men, gives the same origin to all the human race.

The ash does not grow to such thickness as some of the other forest trees. Dr Plot mentions one eight feet in diameter; Mr Marsham another, at Dumbarton, nearly seventeen feet in girth; Arthur Young mentions one in Ireland that had reached the height of nearly eighty feet in thirty-five years; and one is spoken of in the county of Galway, a district not remarkable for timber, as forty-two feet in circumference, at four feet from the ground. Instances of so great dimensions are not numerous, however; and it is not desirable that the ash should be left for such a growth, as trees of fewer years, and inferior scantling, are invariably better timber.

Gilpin, in his work on Forest Scenery, calls the oak the Hercules of the Forest, and the ash the Venus. The chief characteristic of the one is strength; of the other, elegance. The ash carries its principal stem higher than the oak; its whole appearance is that of lightness, and the looseness of the leaves correspond with the lightness of the spray. Its bloom is one of the most beautiful appearances of vegetation. The ash, however, drops its leaves very early; and, instead of contributing its tint to the many-coloured foliage of the autumnal woods, it presents wide blanks of desolated boughs. In old age, too, it loses that grandeur and beauty which the oak preserves.

There are upwards of thirty species of the ash enumerated,—a considerable proportion of these being natives of America.

The *Flowering Ash (f. ornis)*, is a native of the southern parts of Europe, is said to be that which chiefly produces the substance called manna; although other species, as the *excelsior* and *rotundifolia*, also furnish it. This substance is secreted from the inner bark, and is a species of sugar. In Sicily the three species we have mentioned are regularly cultivated for the purpose of procuring manna, and with this view are planted on the declivities of the hills, with an eastern aspect. After ten years they begin to yield this substance, which exudes from incisions made on the bark by means of a sharp crooked instrument. These incisions are first made in the lower part of the trunk, and repeated at the distance of an inch from the former wound, still extending the incisions upwards as far as the branches; and confining them to one side of the tree, the other side being reserved till the year following, when it undergoes the same treatment. On making these incisions, which are of a longitudinal direction, about a span long, and nearly two inches wide, a thick whitish juice immediately begins to flow, which gradually hardens on the bark; and in the course of eight days it acquires the consistence and appearance in which the manna is imported into Britain, when it is collected in baskets and afterwards packed in large chests. Sometimes the manna flows in such abundance from the incisions, that it runs upon the ground and becomes mixed with impurities, unless this is prevented by the interposition of concave leaves, or flat stones. The business of collecting manna usually terminates at the end of September, when the rainy season sets in.

The most useful and important American species are:—

The *White Ash (f. Americana)*, a beautiful tree, with trunk perfectly straight and undivided to the height of forty feet; leaflets three to four inches long, oval, acuminate, and of a light-green colour and undulated surface; the

wood is reddish, and the sap white. This tree is found on the margins of rivers and swamps, and is of quick growth.

The *Black Ash (f. sambucifolia)*, common in the United States and Canada, rising to the height of sixty to seventy feet; and having the buds of a deep blue colour.

The *Red Ash (f. tomentosa)*, very common in the northern and middle States. The lower surface of the leaves and shoots are covered with a reddish down; the bark of a deep brown.

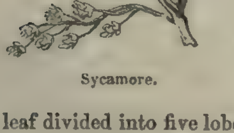
The *Blue Ash (f. quadrangulata)*, confined chiefly to Kentucky and West Tennessee; a large tree, and furnishes a useful wood. Its bark is said to afford a blue dye.

The *Carolinian Ash (f. platicarpa)*, a native of the more southern States; is characterised by its nearly round acuminated leaflets, of which there are commonly only two pairs, with an odd one. It is of much inferior size to the others.

THE MAPLE *(acer)*. Natural family *acerineæ; polygamia, monœcia*, of Linnæus. Of the maple there are a considerable number of species, of which eight are indigenous to Europe, about a dozen to America, and several more to various parts of Asia. Two species are common in Britain, the sycamore and the common maple.

The Great Maple, or Sycamore (acer pseudo-platanus). This is a large growing tree, with a

160.



Sycamore.

large broad leaf divided into five lobes, glaucous, and smooth beneath, the lobes unequally toothed. The flowers hang in long pendulous racemes; the fruit is smooth. This is a fast growing tree, and is well adapted for situations near the sea, as the salt spray seems to have no bad effect on its vegetation. The timber is very close and compact, easily cut, and not liable either to splinter or warp. Sometimes it is of a uniform colour throughout, and in other cases beautifully curled and mottled. In the latter state, as it takes a fine polish, and bears varnishing well, it is much used for certain parts of musical instruments. This wood contains none of those hard particles which are injurious to tools, and is therefore employed for cutting boards; and not being apt to warp, either with variations of heat or of moisture, it is a suitable material for saddle-trees, wooden dishes, founders' patterns, and many other articles both of furniture and machinery. Before the general introduction of pottery-ware, it was the common material for bowls and platters of all sorts, and many are still made of it. As the juice of the maple, both in the leaves and in the tree, is of a sweet taste, numerous insects are attracted to it. At certain seasons the wild bees and wasps may be seen about it in crowds; and if the timber be placed so that insects are allowed to settle upon it, it is speedily attacked by the worm. When kept dry and free from this attack, it will last a considerable time; but exposed to humidity, it is one of the most perishable of trees. From the largeness of its leaves, the maple forms a cool and pleasing shade. It is also a picturesque tree, as the constant excoriation of its bark produces a variety of hues, which serve to diversify the landscape. If pierced in the spring or autumn, a juice flows out which is of a saccharine nature, and may be fermented into wine, or sugar may be obtained from it by evaporation.

The sycamore is not only a large timber tree, but it is long lived. St Hieron, who lived in the fourth century of the Christian era, writes, that he saw the same sycamore tree on which Zaccheus climbed up to see our Saviour ride in triumph into Jerusalem. The propagation of all the maples is very easy. In the autumn, when the seeds are ripe, they are gathered from the tree, dried for a few days, and then sown in any good mould. In the spring the plants will appear, and make a shoot of about a foot by the following autumn.

The Common Maple (acer campestris). This is a smaller tree than the sycamore, with rather smaller leaves. These are cordate, five-lobed, with nearly entire obtuse margins, smooth and shining beneath. The corymbs of the flowers are erect, and the wings of the seeds devaricated. The flower buds begin to open about the 6th of April, and the leaves come out about the 18th of the same month. About the 10th of May the flowers are in full blow, and the seeds ripen in autumn. The timber of this tree is superior to that of the great maple. We meet with high encomiums of its excellence among the ancients. Pliny highly commends the maples, growing in different parts of the world, for the remarkable fineness of their grain; and Virgil introduces Evander sitting on a maple throne. In former times, so eager was the demand for the curious portions of this wood, which, in its veined aspect, often formed representations of birds and various animals, that no pains or expense were spared in procuring them. When boards, large enough for tables, were formed of this curious part of the wood, the extravagant prices paid for them is almost incredible. We read of a table formed

of this wood which cost ten hundred thousand sesterces, and of another that cost upwards of fifteen hundred thousand.

This tree is seldom planted so as to form woods or large plantations. It is more commonly cut down so as to form underwood; for this purpose it is very suitable, as the shoots spring up very fast from the old stools, and they make useful fuel. The largest trees are generally found in hedge-rows.

The Norway Maple (acer platanoides). This species grows to a great size. The leaves are large, like the sycamore, of a shining green colour, five-lobed, acuminate, cuspidate, and somewhat toothed. The corymbs are nearly erect. It grows on the mountains of the northern countries of Europe, descending, in some places of Norway, to the sea shore. It abounds in the north of Poland and Lithuania, and is common throughout Germany, Switzerland, and Savoy. The leaves are not liable to be preyed on by insects, as they contain a milky bitter juice, repulsive to these animals. This circumstance heightens the beauty of the tree; and in spring, when it is full of its yellow blossoms, it has a very fine appearance. In autumn the leaves assume a golden yellow, which adds to the diversified beauty of the surrounding foliage. It thrives well in this country, where its seeds come to maturity, and where it may be propagated in the same way as the other maples. On the continent it is reckoned among the best trees for giving shelter to dwelling-houses. It is of quick growth, and attains a very considerable size. Its wood is also held in great estimation, and its juice yields sugar by evaporation.

The Sugar Maple (acer saccharinum), is also known in America under the name of rock

16'.

Sugar Maple.

maple and hard maple. It is a native of North America, and grows in great abundance in Canada, New Brunswick, and Nova Scotia, the States of Vermont and New Hampshire, the district of Maine, Genesee, New York, and the upper parts of Pennsylvania. According to Dr Rush, in the northern parts of these two latter states, there are ten millions of acres which produce this tree, in the proportion of thirty to the acre. In the middle and southern states it is rare, and almost unknown. It flourishes best in mountainous districts, where the soil, though fertile, is cold and moist; and, in addition to the localities just mentioned, it grows along the whole chain of the Alleghany mountains to their termination in Georgia.

The sugar maple attains the height of seventy to eighty feet, with a diameter in proportion; but its average height is fifty to sixty feet, with a diameter of twelve to eighteen inches. Well grown thriving trees have a beautiful appearance, and are early distinguishable by the whiteness of their bark. The leaves are about five inches broad, and vary in length according to the age of the tree; they are opposite, attached by long petioles, palmated, or unequally divided into five lobes, entire at the edges, of a bright green above, and glaucous or whitish underneath. In autumn the first frosts change them to a red colour. Except in the colour of the lower surface, they nearly resemble the leaves of the Norway maple. The flowers are small, yellowish, and suspended by slender drooping peduncles. The seed is contained in two capsules, united at the base, and terminated in a membranous wing. The wood when cut is white; but after being wrought, and exposed for some time to the light, it assumes a rosy tinge. It is fine and close grained, and, when polished, has a silky lustre. It is very strong and sufficiently heavy, but wants the property of durability, for which the chestnut and the oak are so highly esteemed. When exposed to moisture it soon decays. After a seasoning of two or three years, it is employed by wheelwrights for axle-trees and spokes, and for chairs and other domestic furniture. In the neighbourhood of towns it is much used as fuel. The ashes are rich in alkaline salts; and four-fifths of the potass exported from Boston and New York are the produce of this tree.

But it is chiefly prized for its juice, which affords an excellent sugar, little inferior to that of the sugar cane. The process of obtaining this juice and sugar is very simple. The work generally commences in February or the beginning of March, while the cold continues intense, and the ground is still covered with snow. The sap begins to be in motion at this season, two months before the general revival of vegetation. In a central situation, lying convenient to the trees from which the sap is to be drawn, a shed is erected, called a sugar camp, which is intended to shelter the boilers, and the persons who tend them, from the weather. An auger, three-fourths of an inch in diameter—small troughs to receive the sap—tubes of elder or sumach, eight or ten inches long, corresponding in size to the auger, and laid open for a part of their length —buckets for emptying the troughs, and con-

veying the sap to the camp—boilers, of fifteen or eighteen gallons capacity—moulds to receive the syrup when reduced to a proper consistency for being formed into cakes—and, lastly, axes to cut and split the fuel, are the principal necessaries required in the operation.

The trees are perforated in an obliquely ascending direction, eighteen or twenty inches from the ground, with two holes four or five inches apart. Care should be taken that the augers do not enter more than half an inch within the wood, as experience has shown the most abundant flow of sap to take place at this depth. It is also recommended to insert the tubes on the sunk side of the tree; but this useful hint is not always attended to. A trough is placed on the ground at the foot of each tree, and the sap is every day collected, and temporarily poured into casks, from which it is drawn out to fill the boilers. The evaporation is kept up by a brisk fire, and the scum is carefully taken off during this part of the process. Fresh sap is added from time to time, and the heat is maintained till the liquid is reduced to a syrup, after which it is left to cool, and then strained through a blanket or other woollen stuff, to separate the remaining impurities. Some recommend leaving the syrup twelve hours before boiling it for the last time; others proceed with it immediately. In either case the boilers are only half filled, and by an active steady heat the liquor is rapidly reduced to the proper consistency for being poured into the moulds. The evaporation is known to have proceeded far enough when, upon rubbing a drop of the syrup between the fingers, it is perceived to be granular. If it is in danger of boiling over, a bit of lard, or of butter, is thrown into it, which instantly calms the ebullition. The molasses being drained off from the moulds, the sugar is no longer deliquescent like the raw sugar of the West Indies. Maple sugar manufactured in this way is lighter coloured in proportion to the care with which it is made, and the judgment with which the evaporation is conducted. It is superior to the brown sugar of the colonies, at least to such as is generally used in the United States; its taste is as pleasant, and it is as good for culinary purposes. When refined, it equals in beauty the purest sugar used in Europe. Its use, however, is confined to the districts where it is made, and then only in the country. From prejudice or taste, imported sugar is used in all the small towns and in the inns.*

The sap continues to flow for six weeks, after which it becomes less abundant, less rich in saccharine matter, and sometimes even incapable of crystallization. In this case it is consumed in the state of molasses, which is superior to that of the islands. After three or four days exposure to the sun, maple sap is converted into vinegar by undergoing the acetous fermentation. To make beer of it, one quart of maple molasses is mixed with four gallons of boiling water; to this, when cool, a little yeast and a spoonful of essence of spruce are added, and thus a very pleasant and wholesome beverage is obtained.

It is found that those trees which grow in low and moist places yield more sap than those growing on rising grounds; but it is less rich in sugar. That of single or isolated trees, is also the best. The following operations were made on a tree near Pittsburg: twenty tubes were introduced into a sugar maple, and on the same day 23 gallons 3 quarts of sap were drawn, which yielded 7 pounds and a quarter of sugar. 33 lbs. were made the same season from the same tree, which supposes 100 gallons of sap.

In the United States maple sugar is made in greatest quantities in the upper part of New Hampshire, in Vermont, in the State of New York, particularly in Genesee; and in the counties of Pennsylvania which lie on the eastern and western branches of the Susquehannah, west of the mountains in the country bordering on the Alleghany, Minongahela, and Ohio rivers. The farmers, after laying aside a sufficient store for their own consumption, sell the residue to the shop-keepers in the small towns of the neighbourhood, at eight cents a pound, by whom it is retailed at eleven cents. A great deal of sugar is also made in Upper Canada, and on the Wabash. The Indians dispose of it to the commissioners of the north-western company established at Montreal, for the use of the numerous agents who go out in their employ in quest of furs beyond lake Superior. In Nova Scotia, and the district of Maine, and in the highest mountains of Virginia and Carolina, where these trees are sufficiently common, the manufacture is less considerable; and probably six-sevenths of the inhabitants consume imported sugar.

It has been said, that the northern parts of New York and Pennsylvania contain maples sufficient to supply the consumption of the whole of the United States.

Wild and domestic animals are exceedingly fond of maple juice, and break through the inclosures to sate themselves with it.

Another species, the black sugar maple *(acer nigrum)*, is found growing in the western States; the leaves are similar to the sugar maple, only they are of a deeper green, of a thicker texture, and slightly downy: the wood is coarser grained, and less brilliant when polished.

The *Red Flowering Maple (acer rubrum)*. This is also a common tree in the United States. It is the earliest whose bloom announces the return of spring; and in the neighbourhood of New York is in flower about the middle of March.

* Michaux.

The blossoms are of a beautiful purple, or deep red, and come out about two weeks before the leaves. They are sessile, aggregate, and situated at the extremity of the branches. The leaves are smaller than those of the preceding species, but in some respects are similar. The wood is hard, and well adapted for the turning lathe; and before the introduction of mahogany, was much esteemed for its variegated aspect and the fine polish which it bears.

The French Canadians make sugar from this tree, which they call *plaine*, but the juice is not very strong. A dark blue and black dye is furnished by the bark.

The red maple thrives in wet and swampy situations.

The *Striped Barked Maple (acer striatum)*, has a slender stem, with a smooth bark, beautifully varied with green and white stripes; the boughs are of a shining red in winter. The thickness of the shade, the beauty of the bark, and the tree not being liable to be infested by insects, render it very desirable for ornamental plantations. The only objections to it are, that it is subject to be injured by storms, and that the abundance of its foliage and seeds occasions a great litter in autumn.

The *Italian Maple (acer opalus)*, is a noble tree, with large and beautiful foliage, throwing an extensive shade. It is much prized in Italy for planting in avenues and public walks.

The Birch *(betula)*. Natural family *amentaceæ; monœcia, triandria*, of Linnæus. The birch is a native of cold and inhospitable climates; and the dwarf birch is the last tree that is found as we approach the snow in elevated regions. At the island of Hammerfest, lat. 79° 40′, the dwarf birch, in the sheltered hollows between the mountains, rises to about the height of a man; and in the low branches which creep along the ground, the ptarmigan finds a summer shelter, where it breeds in security. Naturalists affirm that the birch tree constitutes the principal attraction to the birds which are found in such plenty in high northern latitudes; the catkins affording them food in the spring, and the seeds during the remainder of the year.

The *Common Birch (betula alba)*, is a graceful tree, and throws out a pretty strong and very agreeable fragrance. When it arrives at a considerable size, the branches hang down or "weep;" and as they are sometimes thirty or forty feet long, and not thicker than a common packthread, they are very beautiful, especially when the points of them are laved in a clear mountain stream. Coleridge calls the weeping birch the "lady of the woods."

Though the people of more favoured places rather despise the birch tree, and leave it to the turner, out of which to make some of the smaller of his wares, or employ the shoots as mop handles, and the twigs as brooms; there are situations in which it is among the most valued and valuable productions of nature.

In those parts of the Highlands of Scotland where pine is not to be had, the birch is a timber for all uses. The stronger stems are the rafters of the cabin; wattles of the boughs are the walls and the door; even the chests and boxes are of this rude basket work. To the highlander, it forms his spade, his plough, and, if he happen to have one, his cart and his harness; and when other materials are used, the cordage is still withies of twisted birch. These birch ropes are far more durable than ropes of hemp; and the only preparation is to bark the twig, and twist it while green.

In ancient times, both in Britain and other parts of Europe, strong and light canoes were made of the touch bark of the birch; and it is still used for the same purposes in the northern parts of America. The species used for canoes by the Indians and French Canadians is called the canoe birch, *(betula papyracea*, or *betula nigra)*. In good soils it reaches an elevation of seventy feet. The weight of a canoe that will hold four persons, does not exceed fifty pounds.

The peasantry in some parts of northern Europe thatch their houses with the birch, weave the long fibres into mats, and twist them into ropes, and even grind the inner bark to mix with their bread. The bark is used in the simple dyes, and also in tanning. The Laplanders use it in the preparation of their rein-deer skins; and in Russia the hides which are so esteemed for binding books are prepared with the empyreumatic oil of the birch. A weak but not unpleasant wine may be obtained by draining the sap in March, boiling it, and then fermenting it. The Northern people also make very neat baskets and boxes of the bark, the Laplanders carving the large knots which the trees put forth, into vases, which, although fashioned with their rude knives, have much of the beauty of turnery. In Kamtschatka also, it is formed into drinking cups. The wood of the birch on the banks of the Garry, in Glengarry, Scotland, is cut into staves, with which herring barrels are made. It is an excellent wood for the turner, being light, compact, and easily worked; and for undressed palings and gates, such as are used in the sheep countries, few timbers are superior to it. It is not very durable, however, but very cheap, as it thrives upon soils that are fit for little else, and sows itself without any assistance from art. It grows upon rocks which one would think absolutely bare; and such is the power of its roots, that penetrating through fissures, they will separate stones several tons in weight, to reach the soil. The black birch of America has been imported into this country. It is compact

and rather handsome, but it soon decays. Birch makes very good charcoal.

The weeping birch, *b. pendula*, is the most graceful tree of the family. It grows both in mountainous situations and bogs, from Lapland to the subalpine parts of Italy and Asia. The mahogany birch, *b. lenta*, or cherry birch of Canada, abounds in the middle states of Pennsylvania, New York, and the Jerseys; but disappears altogether in the higher latitudes of the northern states. It is deemed a very fit tree for planting in the valleys of the mountainous districts of Britain. Its growth is rapid, and the timber is close-grained; beautifully variegated, and well adapted for cabinet work. The leaves, which appear early in spring, possess a peculiar fragrance, which they retain after being dried in a stove, affording by infusion an agreeable diluent, superior to some of the common teas of commerce. The white bark of the birch contrasts well with the sombre trunks of other trees, and, indeed, all the species are highly ornamental and graceful in gardens and shrubberies.

The *Alder (alnus glutinosa)*, belongs to the same natural family and Linnæan order as the

162.

The Alder.

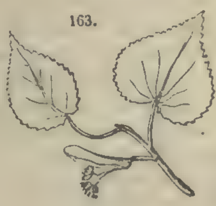
birch; it is not so handsome a tree, however, as the birch, and the timber is not applicable to so many useful purposes. The alder is a native of almost every part of Europe. It thrives best in marshy situations, and by the margins of lakes and rivers, where it is generally a large shrub rather than a tree. As its shade rather improves than injures the grass, coppices of it afford good wintering for the out-door stock on mountain grazings.

The bark of the alder contains a good deal of tannin; and the young shoots dye a yellow or cinnamon colour, the wood a brown, and the catkins of the flowers a green. The twigs of the alder are brittle, and so is the stem when green. In that state it is more easily worked than any other timber. When of considerable size, the timber of one of the varieties (there are several of them) is red, and often so finely streaked, that it is called Scotch mahogany in the north, and furniture is made of it. That which is got out of the bogs, in an undecayed state, (and though it be not so durable in the air as birch, it lasts much longer in water), has the colour, if not the consistency of ebony. Of birch or holly, which are very white, of juniper, which has a slight cinnamon tinge, and of the bog alder or the bog oak, both of which are black, the coopers in the north of Scotland form variegated cups, some of which are very handsome. In moist situations alder does very well for foundation piles; and from the ease with which it can be perforated when green, and from its not being liable to split, it is well adapted for wooden pipes.

On the banks of the Mole, in Surrey, the alder grows very luxuriantly; and it adds great beauty to the landscape in the neighbourhood of Dorking and Esher.

THE LIME TREE *(tilia Europea)*. Natural family *tiliaceæ; polyandria, monogynia*, Lin-

163.



Lime Tree.

næus. The lime is a handsome tree, which attains a considerable size. The leaves are cordate, serrated, unequal at the base, and of a light green colour. The flowers begin to open about the middle of May, and are in full blow by the middle of July, when they appear of a white colour, and have a very fragrant smell, yielding a honey of peculiar and excellent flavour. The leaves begin to open about the 12th of April, are quite out by the end of that month, and begin to fall very early in autumn.

Of the lime there are several species and varieties, characterised chiefly by the size and shape of the leaves; but the most valuable, and the one which is most frequently met with, is the common lime. It is an exceedingly beautiful tree, grows fast, and attains a very great size. It is not supposed to be a native of England, but mention is made of it growing here as early as the middle of the sixteenth century. In Switzerland and Germany there are lime trees of an enormous size; and one, in the county of Norfolk, is mentioned by Sir Thomas Brown as being ninety feet high, with a trunk forty-eight feet in circumference, at a foot and a half from the ground.

The lime bears the smoke of cities better than any other tall-growing forest tree; and for this reason the shaded walks about the cities on the

Continent, more especially in Germany, are planted with it. It has other advantages: the trunk is smooth; the leaves are of a most beautifully delicate green; the flowers throw out a very agreeable fragrance; and it is not so liable to get unsightly, from wounds and decayed branches, as almost any other tree. But its leaves come late in the spring, and they begin to fall early,—as early sometimes as the month of July.

Though a soft and weak timber, the lime is valuable for many purposes. It is delicately white, and of an uniform colour, and therefore it is admirably adapted for all light works that are to be partially painted, and then varnished. Though it be very close in the grain, it blunts the tool less than any other timber; and as it has the same property as maple, of not warping, and even in a higher degree, it is used for cutting-boards, and for the keys of musical instruments. It also stands the tool well, and is called, by way of eminence, "the carver's tree," being used by the carvers and gilders for most parts of their wooden ornaments. At iron foundries, the ornaments for the fronts of stoves and other purposes are all first cut in lime tree, and some of them are moulded from the carving, though casts be more generally taken in lead, as being more durable, and admitting of a smoother surface. The exquisite carvings with which Grindling Gibbons ornamented so many of the churches and palaces in England, in the time of Charles II., are all executed in lime tree. Lime, though softer and more easily cut than beech or maple, is not so much affected either by the worm or by rot.

The bark of the lime tree is an article of commerce. As the trunk of the tree is tall and free from knots, the bark may be stripped off in long pieces. These are macerated in water till the fibrous layers separate; and are then divided into narrow slips, called *bast*, which, in the northern parts of Europe, are plaited into ropes, and worked into mats. The mats in which flax and hemp are imported from the Baltic, and which, in this country, are in constant use by gardeners for covering plants from the weather, and tying them up, and also for market and tool baskets, are made of *bast*, or the bark of the lime tree. Though the lime be not so great a favourite in this country as it was in former times, it may very fairly be doubted whether the poplars, and other soft, fast-growing trees that have been substituted for it, are a change for the better. The lime is not a tree for bleak and cold lands. It thrives best in rich loam, and in warm and rather moist situations; and though the average age to which it will grow has not been accurately determined, yet, from the healthy nature of the tree, and the great size that it has arrived at, it must be considerable—upwards of a hundred years.

The lime is generally raised from seeds, which produce the handsomest trees; it may, however, be propagated by cuttings or suckers. The seeds are collected and dried for a few weeks, and then sown in a rich mould in autumn. They will spring up in the following spring, and after two years' age may be planted out.

The honey made from the flowers of the lime, is reckoned the finest in the world. Near Kowno, in Lithuania, there are large forests chiefly of this tree. The honey produced in these forests, sells at more than double the price of any other, and is used exclusively in medicine, and for mixing with liquors.

It was customary with the ancients to crown themselves with garlands of roses and other flowers during their convivial entertainments; and these were artfully bound together with slips of the inner rind of the lime tree.

The *American Lime (t. Americana)*, of which there are several varieties, very nearly resembles the European species. The leaves, which vary in size according to the varieties, are finely serrated on the edges, and end in acute points, with the under surface of a paler green than the upper. The large-leaved is by far the finest sort; and the branches of this species vary from all the others, in having a dark brown bark. The flowers are furnished with nectaries; whereas those of the common lime have none. They are produced in bunches, and are succeeded by seeds contained in coriaceous capsules.

The Horse Chestnut *(æsculus hippocastanum)*. Natural family *hippocastaneæ; heptandria, monogynia*, of Linnæus. This tree is a native of the northern or central parts of Asia, from which it was introduced into Europe about the middle of the sixteenth century. Its progress can be traced from parts of Northern Asia to Constantinople, thence to Vienna, and thence to Paris, where the first tree was planted in 1615. It is very beautiful in the arrangement of its branches, which give it the form of a paraboloid; in the shape of its leaves; and in its pyramids of large white flowers, delicately marked with red and yellow. It grows very rapidly, and to a great height; but the timber is soft, spongy, and not durable, and therefore of little value. It is white, but every way inferior to the lime, as it does not stand the tool, and almost any thing will scratch it. It has sometimes been used by the turner, and also for pipes; but though it be cheap, the advantage of using it is very questionable. As it requires a good soil, it is not worth cultivating but as an ornamental tree. The Turks are said to grind the nuts, and mix them with the food of their horses (whence the common name): they devour them with avidity, and they are stated to be eaten whole by deer and sheep, and by poultry when boiled; but hogs refuse them both raw and prepared. The

bark of the horse chestnut has been employed with some success in dyeing yellow.

This tree is extremely well adapted for the ornament of parks and pleasure grounds, as it grows to a large size, and forms a beautiful regular head. The buds, before they shoot out, become turgid and large, so that they have a good effect to the eye by their bold appearance, long before the leaves appear. A peculiarity of these buds is, that as soon as the leading shoot bursts out, it continues to grow so fast as to be able to form its whole summer's shoot in about three weeks or a month's time. After this it grows little more in length, but thickens, and becomes strong and woody, and forms the buds for the next year's shoot. The flowers are in full blow about the 12th of May, and on fine trees make a noble appearance. This tree is generally raised from the nuts. These should be collected in autumn, and sown in spring. If the nuts, previous to being put into the ground, are steeped for a short time in water, they will more certainly, and more quickly spring up into plants.

The Poplar *(populus)*. Natural family *amentaceæ; diœcia, octandria,* of Linnæus. In ancient times the public places of Rome were planted with rows of this tree, whence it came to be called *arbor populi*, and from this probably we derive the common name it now bears.

There are about sixteen species of this family enumerated. Their general aspect is that of tall, straight, and light trees, with the branches in general rising up perpendicularly instead of spreading out horizontally.

The leaves vary in size and shape in the different species; generally they are small, oval, cordate, or deltoid, with long, slender petioles, and light coloured on the under side. The flowers are male and female, on distinct plants, and both are arranged in the form of an amentum. The flowers appear about the beginning of April, and in two months the seeds are perfected.

The small-leaved white poplar is a native of most parts of Europe; but it is doubtful whether the large-leaved one, the abele, be a native of England,—at all events, the plants of it were obtained chiefly from Flanders in the seventeenth century. The poplar grows very rapidly. In favourable situations it will make shoots three inches in diameter, and sixteen feet long, in the course of a single season. The loppings of the poplar are not very inflammable, and thus they are superior to those of the elm, and many other trees, for heating ovens, and for other purposes in which the loppings of trees are used.

The wood of the poplar is soft, and it is far from durable; but it is not apt either to swell and shrink, or to warp, and it is very light, so that it is employed for butchers' trays, hogs' troughs, and other articles, in which lightness and cheapness are preferred to durability. It is possible, in consequence of the rapidity with which the poplar grows, and the ease with which it can be worked, that, on the spot where it is produced, it may be more economical for common household purposes, and for casks and packages for dry goods, than more durable timber. It is a tree largely cultivated by the Dutch, being well adapted to their moist soil and climate. On the Continent a species of poplar is manufactured into thin slices, called *sparterie*, which is made up into ladies' bonnets. The seeds of the white poplar, also, are surrounded with a sort of cotton, of which it has been attempted to manufacture paper and even cloth. Pallas, in his voyages, attempted to show that the cotton of the *Populus alba* was as valuable as that of America; but no experiments upon it have yet been successful.

In Holland, the *black* poplar is also much cultivated. It grows rapidly, is cut down at about twenty-four years old, and made into wooden shoes, and other articles. The timber is of nearly the same quality as that of the white poplar, perhaps a little better; and it is used for almost the same purposes.

The *trembling* poplar, or *aspen*, is singular on account of the agitation of its leaves by the slightest breeze that can stir. It is very generally diffused, and the timber of it, though it does not attain quite the same size, is applied to the same purposes.

The leaves of almost all the poplars are of a pale or silver colour on the under sides, and the twigs are flexible, which gives them an agreeable variation of colour when agitated by the wind. The susceptibility of motion is one of the accidental beauties of trees; and the motion of the poplar is peculiarly graceful, for it waves in one simple sweep from the top to the bottom, and the least breath of wind stirs it, when other trees are at rest.

The Lombardy poplar grows rapidly, and shoots in a compact spire to a great height. It is not so hardy as the others; but when planted in a favourable soil, it will grow at the rate of four or five feet in height annually.

The timber of the Lombardy poplar is even worse than that of the other poplars; but for temporary purposes the rapidity of its growth is some compensation. It is, perhaps, the lightest of timber, and, therefore, well calculated for packing-cases; and though soft, it will bear some strain without breaking. The vessels in which the people of Lombardy carry and squeeze their grapes are all made of this poplar; and they also frequently train their vines to the tree. In England it is chiefly used as an ornamental tree. The Lombardy poplar is, so far as has been observed, the only spiry tree that is deciduous, or sheds its leaves: the tree which it most nearly

resembles in its form, though not in its foliage, is the cypress.

The balsam poplar is a moderate sized conical tree, a native both of Siberia and America: the buds of this tree, from autumn to the leafing season, are covered with a quantity of a glutinous yellow balsam, which often collects into drops, and is pressed from the tree for medical use. This balsam is brought to Europe from Canada in shells. It is smooth, of an even texture, yellow colour, and fragrant scent, not unlike the flavour of Tolu balsam. In Siberia a medicated wine is prepared from the buds, which is diuretic, and esteemed by the inhabitants as serviceable in scurvy. The grouse and other game birds feeding on these buds during winter, acquire a flavour which is much esteemed by epicures.

All the poplars are very easily raised from cuttings: they prefer a moist soil, and are of a very rapid growth, but do not last long.

The chief species and varieties are thus distinguished.

White Poplar (p. alba), with roundish leaves, angularly indented, and downy on the under side; trunk straight, and covered with a smooth whitish bark. A variety with larger leaves is called the abele poplar.

Black Poplar (p. nigra), with pointed, serrated leaves; shaped like the letter delta, Δ, and smaller than those of the former tree.

Lombardy Poplar (p. dilatata), with leaves smooth on each side; pointed, serrated, and deltoid, broader than long. Branches in form of a cone.

Aspen, or *Trembling Poplar (p. tremula)*, with roundish, broadly toothed leaves, smooth on both sides; leafstalks compressed, and long and slender, moving with the least breath of wind.

Balsam Poplar (p. balsamifera), with oval pointed leaves, closely serrated, and netted beneath: the buds are resinous, and of a pale yellow colour. This tree is of a very quick growth, and attains a considerable size.

The Willow *(salix)*. Natural family *amentaceæ; diœcia, diandria*, of Linnæus. Of the willow family there have been enumerated about one hundred and forty species and varieties. The willow is a light, graceful, and quick growing tree, with generally narrow, lanceolate, and serrated leaves. It flourishes on the banks of rivers and lakes, and other moist situations, and is confined chiefly to the temperate regions of Europe and America. Many of the species are distinguished by such delicate shades, that it becomes very difficult to particularize and distinguish them. Soil, situation, and climate, produce so considerable a change in their appearance, as to render it difficult to determine what are species and what are varieties. Those kinds which attain a timber size, are chiefly valued for the rapidity of their growth, they produce a great bulk of trunk, and lop in a short time; and the bark of most of the species has recently been used in tanning, being, at an average of sorts, about half as valuable as that of the oak. One great use of the willow is for basket making.

The basket-making willows, at least those most generally and frequently used for that purpose, (for baskets may be made of the twigs of many others)—are the *osier (salix viminalis)*; and the *yellow willow (salix vitellina)*; the timber tree is the *white willow (salix alba)*; and the ornamental one, the *weeping willow (salix Babylonica)*.

164.

a The Osier; *b* White Willow.

The osier is a native of most parts of Europe, and grows spontaneously in fenny places. When allowed, it becomes a small tree, but it is generally cut down for basket-work. The osier grows very rapidly; and is used only for the coarser basket-work, unless when split into pieces. On the banks of large rivers, osier beds may be planted with great advantage; and the osier will also thrive in dry situations if the soil be good. Cuttings of osiers take root very readily, and it is not of much consequence which end of them be put into the ground. They are of great use in giving consistency to banks and embankments, which are in danger of being washed away. There are many osier beds in the Thames, which are generally cut about once in three years, and are very profitable to their proprietors.

The shoots of the yellow willow are much more slender than those of the osier: they are very tough; and on that account they are well adapted for the finer kinds of basket-work.

In common language, osier is used for almost any willow tree, while of that which botanists call the osier there are many varieties.

The white arborescent willow grows to a large size, by the sides of rivers; and when the wind agitates its twigs, and turns up the silvery sides of its leaves, it has a fine appearance. It is a native of most parts of Europe.

The weeping willow is a native of the Levant; but it thrives very well in England, if the situation be not too cold for it, and if it be near

water. It runs to a considerable height, and no tree can be more graceful on the margin of a lake or stream. The twigs, which hang down so beautifully, are tough, as well as long and slender; and there can be no doubt that they would answer well for basket-making; but this tree is chiefly introduced on account of the beauty of its appearance. It has been said, that the first willow was planted in England by the celebrated Alexander Pope. According to the account of this circumstance, the poet having received a present of figs from Turkey, observed a twig of the basket in which they were packed putting out a shoot. He planted this twig in his garden, and it soon became a fine tree; from which stock many of the weeping willows in England have sprung. This tree, so remarkable on every account, was cut down a few years ago.

The willow has not only been noticed, but employed in basket work in this country from a very early period, and there is some probability that the Britons taught the art to the Romans, at least, from the mention of a basket brought to Rome by painted Britons, in Martial, we should be led to infer that baskets of British manufacture were esteemed in the capital of the world.

The timber of the willow is applicable to many purposes similar to those in which the poplar is employed, and in toughness it is far superior. The ancient Britons sometimes made their boats of basket-work of willow, and covered them with the skins of animals: they were remarkably light and buoyant.

The willow is used extensively in the manufacture of charcoal; and it has been found to be superior to most other woods in producing charcoal, for gunpowder. A good deal depends, however, upon the manufacture. In the ordinary modes of making charcoal, by building the wood up in a pyramidal form, covering the pile with clay or earth, and leaving a few air-holes, which are closed as soon as the mass is well lighted, combustion is imperfectly performed. For charcoal, to be used in the manufacture of gunpowder, the wood should be ignited in iron cylinders, so that every portion of vinegar and tar which it produces should be suffered to escape. In India, charcoal is manufactured by a particular caste, who dwell entirely in the woods, and have neither intermarriage nor intercourse with the Hindoo inhabitants of the open country. They bring down their loads of charcoal to particular spots, whence it is carried away by the latter people, who deposit rice, clothing, and iron tools, a payment settled by custom. The benevolent bishop Heber wished to mitigate the condition of these unfortunate people, but he found that he could not break through the Hindoo prejudice against them. Evelyn, in his Sylva, fears that the progress of our iron manufacture would lead to the destruction of all our timber, in the preparation of charcoal for furnaces. He did not foresee that we should find a substitute, by charring pit coal into coke. In 1788, there were eighty-six iron furnaces in England, of which twenty-six were heated by charcoal of wood; in 1826, there were three hundred and five, all served by coke.

The flowers of the sallow willow make their appearance about the 10th of March; and those of the others follow in succession. The leaves are out by the second week of April. They are all of uncommon facility of propagation and culture, and are readily raised from cuttings. Plantations for basket-work or hoops, should be made on deep loamy soil on the banks of rivers, within reach of water, but by no means saturated with it. Few willows are either bog or marsh plants. The cuttings should be of two year's wood, or the strongest portions of one year's growth, two and a half feet long, one foot and a half of which should be put into the ground. They are commonly planted in rows two and a half feet distant each way. After three years they should be cut down to the first planted head; after this the stock will afford an annual crop of twigs. According to Dr Hunter, willow plantations yield £5 per acre and upwards, according to situation and demand.

Among the many uses to which the willow was applied by the Romans, was that of binders to tie up the vines to their poles. Regular plantations of the willow were raised for this purpose. The weeping willow, so called from its pendulous branches and leaves, which often contain a crystal drop of water at their points, was the emblem of grief and disappointment. Thus Shakspeare writes, "I offered him my company to a willow tree to make him a garland, as being forsaken." It is probable that under those trees, the children of Israel mourned their captivity. "By the rivers of Babylon, there we sat down, yea, we wept when we remembered Zion. We hanged our harps upon the willows in the midst thereof."—*Psalms.*

The *salix herbacea*, which is not a herbaceous plant, as the name would imply, but really a tree, is the smallest of all trees yet known, being only from one to three inches in height, even when of mature age.

The Mountain Ash *(pyrus aucuparia).* Natural family *rosaceæ; icosandria, di-pentaginea*, of Linnæus. This is also called the *wild service*, *quickbeam*, and *rowan tree*. This tree grows naturally in many parts of England, and is frequently introduced into plantations and ornamental shrubberies, both for the beauty of the leaves, and the brilliant red of its clusters of berries. In the south of England it is rarely permitted to grow to any height; but in the northern counties, and in Scotland and Wales, it frequently

attains a considerable size. The stems are covered with a smooth gray bark; the branches, while young, have a purplish brown bark, and the leaves are winged. They are composed of eight or nine pair of long narrow lobes, terminated by an odd one. The lobes are about two inches long, and half an inch broad towards the base, ending in acute points; and are sharply sawed on their edges. The leaves on the young trees in the spring, are hoary on their under side, which about midsummer goes off; but those upon the older branches have very little at any season. The flowers are produced in large bunches almost in form of umbels, at the end of the branches. They are composed of fine, spreading, concave petals, shaped like those of the pear tree, but smaller; these are succeeded by roundish berries growing in large bunches, which have a depression on the top, and are of a bright red when ripe. The buds of this tree begin to open about the beginning of April. The leaves are out by the middle of the month, and the flowers are in full blow by the sixth of May. This tree is raised from seeds, which, when planted, frequently remain till the second spring before they make their appearance. In the following spring the young trees should be planted out. It may also be raised from layers; but trees from these are not so handsome as seedlings. It will grow in almost any soil or exposure, flourishing on mountains, or in woods and thickets; and is so hardy as never to be affected by the severity of the weather. In autumn, when loaded with its clusters of red berries, it has a rich and striking effect among shrubberies and ornamental grounds. The wood is used for tools, and was formerly made into bows.

Another species, the true service, we have already shortly described under the head of fruit trees.

Laburnum *(cytisus)*. This family of ornamental shrubs belongs to the *leguminosæ* or pea tribe, to which they are allied by the similarity of their organs of fructification. They may be considered rather as shrubs than trees, and are very ornamental from the handsome form of their leaves, which are composed of small oval leaflets, and the beauty of their dependent racemes of gay coloured flowers. There are two species of the common laburnum, which are so much alike, as often to be confounded together.

The *c. alpinus* is the tree laburnum, whose timber is much prized by cabinet makers and turners for its hard, compact, durable structure, and which is called false ebony by the French. Hares and rabbits are so fond of the bark of this species, that it is frequently planted on the outskirts of other plantations in order to protect the more valuable trees. Though eaten to the ground in winter, it will spring again next season; and thus afford a constant supply for these animals, so as to save the other trees till of a size to resist their attacks. The timber has been sold as high as ten shillings per foot, and is most valuable when grown in light loams and sandy soils.

Even of the small size to which it is permitted to grow, this wood is used for many purposes, as wedges, pulleys, pegs, and handles of knives, and other instruments. When of larger dimensions, no timber is fitter for cabinet work of all kinds. It takes a fine polish, looks well, and is durable. Chairs made of it are stronger than those made of mahogany. It has been objected to the wood, however, that in consequence of its oily nature, it does not hold glue so well as the drier woods. This property, on the other hand, fits it well for pins, blocks, and cogs, in mill-work, as its unctuous nature prevents it from being abraded. Many of the purposes for which it was once used, are now supplied by lignum vitæ, which is a harder wood, and still more unctuous; but it is more splintry. For pillars, bed posts, feet for tables, and other purposes, laburnum wood is well adapted, and frequently used.

The seeds are possessed of narcotic and poisonous qualities; and it is said that if a garland of the flowers be worn around the neck, that they produce headache.

The purple-flowered, and winged-leaved species, *purpureus* and *wolgaricus*, are very handsome and ornamental shrubs, and are frequently engrafted on stocks of the common laburnum five or six feet in height.

The *medicago arborea* is, as we have already stated, supposed to be the *cytisus* alluded to by Virgil and the ancients.

The *Pigeon Pea (cytisus cagan)*, is frequently planted in the West India islands chiefly in rows, as a fence to the sugar plantations; and will thrive on very barren land. The seed is eaten by the negroes, and is esteemed a wholesome pulse. In the island of Martinico, the better sort of people hold it in estimation, and prefer it to the European pea: the chief use of it in Jamaica is for feeding pigeons, whence its name. The branches, with the ripe seed and leaves, are given to feed hogs, horses, and other cattle, which grow very fat on them.

Acacia *(robinia)*. Natural family *leguminosæ; diadelphia, decandria*, of Linnæus. This is a family of useful and ornamental trees; natives of America, and allied in their general appearance to the foregoing. The common acacia is a thriving, fast growing tree, of middling stature, and ornamental when young; and very well adapted for copse wood and rough timber. The leaves come out late in spring, and fall off early in autumn, like those of the ash.

This is the *locust tree* of America, the timber of which is much valued there, and is said to

be superior to that of the laburnum, being close grained, hard, and finely veined, and highly valued by the turner. Being of a very incorruptible nature, it is also valuable for posts, rails, and gates, many of which, made of this wood, have remained fresh for nearly a century. Its delicate, finely-shaped, pinnated leaves, and white, pendulous, odorous flowers, also recommend it as an ornamental shrub. It thrives best in a deep sandy soil, and sheltered situation, and throws up suckers abundantly from the roots, thus adapting it for coppice wood. It is also recommended as possessing superior qualities to the oak for ship-building; but its comparative scarcity has hitherto prevented its extensive use in this department.

Dogwood *(cornus)*. Natural family *caprifoliæ; tetrandria, monogynia,* of Linnæus. There are ten or eleven species of this family, all characterised by the hardness of their wood. The larger kinds are very ornamental and hardy shrubs, not only from the beauty of the flowers, and the gay colour of the berries, but also from the diversified colours of their barks and young shoots, which have a lively effect, especially in winter, among other more monotonous shrubbery. The great-flowered, *c. florida,* an American species, is thus described by Michaux:—The dogwood sometimes reaches thirty to thirty-five feet in height, and nine or ten inches in diameter; but it does not usually reach more than eighteen or twenty feet. The trunk is strong, and is covered with a blackish bark, chopped into many small portions, which are often in the shape of squares more or less exact. The branches are proportionally less numerous than on other trees, and are regularly disposed nearly in the form of crosses. The young twigs incline upwards in a semicircular direction. The leaves are opposite, about three inches in length, oval, of a dark green above, and whitish beneath. The upper surface is very distinctly sulcated. Towards the close of summer they are often marked with black spots; and at the approach of winter they change to a dull red. The flowers are full blown about the middle of May, before the leaves have yet unfolded themselves. The flowers are small, yellowish, and collected in bunches, which are surrounded with a very large involucre, composed of four white floral leaves, sometimes inclining to violet. This constitutes all the beauty of the flowers, which are very numerous; and which in their season robe the tree in white, like a full blown apple tree, and render it one of the fairest ornaments of the American forest. The berries are of a vivid glossy red, of an oval shape, and always united. They remain upon the trees till the first frosts, when, notwithstanding their bitterness, they are devoured by the robin, or migratory thrush, which about this period arrives from the northern regions. The wood is hard, compact, heavy, and fine grained, and is susceptible of a brilliant polish. The alburnum is perfectly white, and the heart is of a chocolate colour. This tree is not large enough for works which require pieces of considerable volume; it is used for the handles of light tools, and agricultural implements, cogs of mill wheels, and other purposes. The inner bark is extremely bitter, and has been used in agues: it will also make a good ink, in the proportion of half an ounce of the bark to two scruples of sulphate of iron; and the same quantity of gum Arabic mixed with sixteen ounces of rain water.

This species grows and blossoms, but does not bear berries in Britain.

The *Common Cornel Cherry (cornus mascula),* blossoms early in this country, and bears handsome berries, which were formerly made into tarts, and formed the *rob de cornis.* The wood is very hard, and is celebrated by Virgil as a material for warlike weapons, "*bona bello cornus.*" The common and blue-berried cornels have red twigs, and are used as ornamental shrubs. The wood of both is hard and useful, and an oil may be extracted from the berries. The wood of the common dogwood makes a very superior charcoal, used in the manufacture of the finest kinds of gunpowder.

The dwarf species, *(succica)* is common in the highlands of Scotland, and other alpine regions; and its berries are esteemed tonic and stomachic.

Lancewood *(gualtheria virgata)*. Natural family *annonaceæ; polyandria, polygynia,* of Linnæus. This tree is a native of Jamaica; and though of moderate size, is one of the most useful and valuable in the island. It possesses in a high degree the qualities of toughness and elasticity, and is, on this account, extremely well adapted for the shafts of light carriages, and all those uses where light, strong, but elastic timber is required. Ash of the very best qualities is found to be inferior to this wood, both in strength and elasticity; while the ash is open in the grain, whereas the other is close and compact.

The leaves are ovate, acuminate, very smooth, with very short footstalks. The blossoms are pedunculate, axillary, and single-flowered.

Hawthorn *(cratægus)*. Natural family *rosaceæ; icosandria, di-pentagynia,* of Linnæus. This is a family of hard-wooded trees, both useful and ornamental. The common hawthorn, *c. oxycantha,* or sharp spined, is the best hedge plant in Europe; and some of its varieties are also very beautiful and ornamental, when in full blossom. The flowers appear in May; hence the popular name of May or May blossom. One variety, the Glastonbury thorn, to which the monks of the dark ages attached a popular legend, flowers in January or February, and in favourable seasons and situations, as early as Christmas.

When young, the hawthorn springs up very rapidly; a shoot of a single year being sufficient for a walking-stick. It thus, if well pruned and kept down, very quickly grows into a thick and intricately woven hedge. When it arrives at the height of a tree, however, it makes wood very slowly, and lives to a great age. The trunk of an old hawthorn has a gnarled, rough, and very picturesque effect, supporting its crown of branches, white with innumerable blossoms. Sometimes these trunks split into two or more divisions, and thus in time gradually becoming covered over with an extension of the bark, appear as distinct stems.

The timber of the hawthorn is extremely hard and durable, and fit for many purposes of utility. There are several distinct species, and many varieties of the hawthorn, all natives of Europe and America. The double-flowering is one of the most ornamental for shrubberies. The fruit of the sweet-scented, *odoratissima*, is reckoned very agreeable; and that of the *azarole* is much esteemed in the south of Europe: in this country it rarely arrives at perfection.

CHAP. XLIII.

MAHOGANY, LIGNUMVITEÆ, TEAK, MAGNOLIA, TULIP TREE, &C.

MAHOGANY TREE *(swietinea mahogani)*. Natural family *meliaceæ; decandria, monogynia*, of

165.

Mahogany Tree.

Linnæus. This is a very large and graceful tree, with numerous spreading branches. The trunk is of great size, covered with a rough, scaly, brown bark, which on the younger branches is of a gray colour. The leaves are compound; the leaflets are pinnated, in three or four, rarely five pairs, without any odd one at the top. They are entire, ovately lance-shaped, oblique, reclining, smooth, and about two inches and a half long. The flowers are small, of a white colour; the calyx bell-shaped. The capsule is ovate, large, five-celled, and contains numerous compressed seeds. It is a native of the West India islands, and the warmer parts of the adjoining continent of America; and has become celebrated, and in request, from the beauty and durability of its wood. The trees on the Bahama islands are not so large, but are more curiously veined; and are known in Europe as Madeira wood.

Swietenia mahogani is, perhaps, the most majestic of trees; for though some rise to a greater height, this tree, like the oak and the cedar, impresses the spectator with the strongest feelings of its firmness and duration. In the rich valleys among the mountains of Cuba, and those that open upon the bay of Honduras, the mahogany expands to so giant a trunk, divides into so many massy arms, and throws the shade of its shining green leaves, spotted with tufts of pearly flowers, over so vast an extent of surface, that it is difficult to imagine a vegetable production combining in such a degree the qualities of elegance and strength, of beauty and sublimity. The precise period of its growth is not accurately known; but as, when large, it changes but little during the life of a man, the time of its arriving at maturity is probably not less than two hundred years. Some idea of its size, and also of its commercial value, may be formed from the fact that a single log, imported at Liverpool, weighed nearly seven tons; was in the first instance, sold for £378; resold for £525; and would, had the dealers been certain of its quality, been worth £1000. Mahogany of remarkable fineness is very costly, being much prized as a fancy wood.

As is the case with much other timber, the finest mahogany trees, both for size and quality, are not in the most accessible situations; and as it is always imported in large masses, the transportation of it for any distance overland is so difficult, that the very best trees, both on the islands and on the main land—those that grow in the rich inland valleys—defy the means of removal possessed by the natives. Masses of from six to eight tons are not very easily moved in any country; and in a mountainous and rocky one, where much attention is not paid to mechanical power, to move them is impossible. In Cuba, the inhabitants have neither enterprise nor skill adequate to felling the mahogany trees, and transporting them to the shore; and thus the finest timber remains unused.

The discovery of this beautiful timber was accidental, and its introduction into notice was slow. The first mention of it is that it was used in the repair of some of Sir Walter Raleigh's ships, at Trinidad, in 1597. Its finely variegated tints were admired; but in that age the dream of El Dorado caused matters of more value to be neglected. The first that was brought

to England was about the beginning of the last century; a few planks having been sent to Dr Gibbons, of London, by a brother who was a West India captain. The Doctor was erecting a house in King Street, Covent Garden, and gave the planks to the workmen, who rejected it as being too hard. The Doctor's cabinet maker, named Wollaston, was employed to make a candle-box of it, and as he was sawing up the plank he also complained of the hardness of the timber. But when the candle-box was finished, it outshone in beauty all the Doctor's other furniture, and became an object of curiosity and exhibition. The wood was then taken into favour: Dr Gibbons had a bureau made of it, and the Duchess of Buckingham another; and the despised mahogany now became a prominent article of luxury, and at the same time raised the fortunes of the cabinet maker, by whom it had been at first so little regarded.

The mahogany tree is found in great quantities on the low and woody lands, and even upon the rocks in the countries on the western shores of the Caribbean sea, about Honduras and Campeachy. It is also abundant in the islands of Cuba and Hayti, and it used to be plentiful in Jamaica, where it was of excellent quality; but most of the larger trees have been cut down. It was formerly abundant on the Bahamas, where it grew, on the rocks, to a great height, and four feet in diameter. In the earliest periods it was much used by the Spaniards in ship building. When first introduced by them it was very dark and hard, and without much of that beautiful variety of colour which now renders it superior to all other timber for cabinet work; but it was more durable, and took a higher polish with less labour. At that time it was called Madeira wood, though it appears to have come from San Domingo (Hayti) and the Bahamas. Of course it was wholly unknown to the ancients. It was first introduced in the sixteenth century, but it was not generally used in England till the eighteenth.

This tree so far corresponds with the pine tribe, that the timber is best upon the coldest soils, and in the most exposed situations. When it grows upon moist soils and warm lands, it is soft, coarse, spongy, and contains sap-wood, into which some worms will eat. That which is most accessible at Honduras is of this description; and therefore it is only used for coarser works, or for a ground on which to lay veneers of the choicer sorts. For the latter purpose it is well adapted, as it holds glue better than deal, and, when properly seasoned, is not so apt to warp or to be eaten by insects. When it grows in favourable situations, where it has room to spread, it is of much better quality, and puts out large branches, the junctions of which with the stem furnish those beautifully curled pieces of which the choicest veneers are made. When among rocks, and much exposed, the size is inferior, and there is not so much breadth or variety of shading; but the timber is far superior, and the colour is more rich. The last description is by far the strongest, and is therefore the best adapted for chairs, the legs of tables, and other purposes in which a moderate size has to bear a considerable strain. Since the produce of Jamaica has been nearly exhausted, there are only two kinds known in the market. Bay wood, or that which is got from the continent of America, and Spanish wood, or the produce of the islands chiefly of Cuba and Hayti. Though the Bay wood be inferior to the other both in value and in price, it is often very beautiful, and may be obtained in logs as large as six feet square. It is, however, not nearly so compact as the other; the grain is apt to rise in polishing, and, if it be not covered by a waterproof varnish, it is very easily stained. It also *gives to the tool* in carving, and is not well adapted for ornaments. Spanish wood cuts well, takes a fine polish, resists scratches, stains, and fractures much better, and is generally the only sort upon which much or delicate workmanship should be expended. The colours of mahogany do not come well out without the application of oil or varnish; and if the best sorts be often washed with water, or long macerated in it, they lose their beauty, and become of a dingy brown. The red is deepened by alkaline applications, especially lime-water; but strong acids destroy the colour. When the surface is covered by a colourless varnish, which displays the natural tints without altering any of them, good mahogany appears to the greatest advantage.

Another species, the *febrifuga*, or East India mahogany, is a very large tree. It grows in the mountainous parts of central Hindostan, rises to a great height with a straight trunk, which, towards the upper part, throws out many branches. The head is spreading, and the leaves have some resemblance to those of the American species. The wood is of a dull red colour, not so beautiful as common mahógany, but much harder, heavier, and more durable. The natives of India account it the most lasting timber that their country produces, and therefore they employ it in their sacred edifices, and upon every occasion where they wish to combine strength with durability.

The *chloroxylon* is chiefly found in the mountains of the Sircars, that run parallel to the bay of Bengal, to the north-east of the mouth of the river Godovery. The tree does not attain the same size as either of the former, and the appearance of the wood is different. It is of a deep yellow, nearly of the same colour as box, from which it does not differ much in durability; and it could be applied to the same purposes.

Mahogany bark has been ascertained by Drs Wright and Lind, to possess all the febrifuge qualities of the Peruvian bark, and has been employed instead of this latter. It is said, indeed, to contain a larger proportion of the bitter principle than the Peruvian bark, and to have other qualities to recommend it in medicine.

LIGNUMVITÆ. The *lignumvitæ* of commerce (*guaiacum officinale*) is a dark-looking evergreen, and grows to a great size in the West India islands, of which it is a native. It bears blue flowers, which are succeeded by roundish capsules. In its native climate the lignumvitæ is a very hardy tree, and retains its greenness in the dryest weather. It strikes its roots deep into the ground, and thus defies the hurricane as well as the drought. The bark is hard, smooth, and brittle; and the wood is of a yellowish, or, rather olive colour, with the grain crossing in a sort of irregular lozenge-work. Lignumvitæ is the weightiest timber with which we are acquainted, and it is the most difficult to work. It can hardly be split, but breaks into pieces like a stone or crystallized metal. It is full of resinous juice, which prevents oil or water from working into it; and it is, therefore, proof against decay. Its weight and hardness make it the very best timber for stampers and mallets of all sorts; and its resinous matter fits it the best for the sheaves or pulleys of blocks, and for friction rollers and castors. A sheave of lignumvitæ cuts a wooden pin less, and is less cut by a metal one, than a sheave of any other timber; while its own sap makes it work as smoothly as other timber even when smeared with grease, black lead, or any other anti-attrition application. Lignumvitæ is much used in our dock-yards for sheaves; and its application may be seen upon a grand scale, in the beautiful block-machinery at Portsmouth.

When full grown, the largest lignumvitæ trees are from forty to fifty feet in height, and from fourteen to eighteen inches in diameter. Like the other resinous trees, it contains sapwood, which is of lighter colour than the heart; but, though not so hard, the light part is a weighty and strong timber, and not liable to separate from the other.

The resin of the lignumvitæ, *gum guaiacum* of the shops, may be obtained by bleeding the live tree, and also by boiling the chips and sawdust of the wood. It is aromatic, slightly bitter, and prescribed in chronic rheumatisms, and other diseases. The capsules and also the bark are aperient, and used in medicine, the former being the more powerful.

The lignumvitæ has been reared by artificial heat in this country; but, as it grows slowly even in the West Indies, its growth here must of course be still slower, and therefore it does not admit of being cultivated, except in botanical collections, or as a curiosity.

THE TEAK TREE (*tectonia grandis*). Natural family *verbenaceæ; pentandria, mongynia,* of

166.

Teak Tree.

Linnæus. It is extensively used in the East, in the construction of houses and temples; and its leaves furnish a purple dye of much brilliancy. This interesting tree is called *tecca* in Malabar; it grows to a very great size, is of great durability, and is justly entitled to the name of the oak of the East. The trunk is erect and massive, the bark ash-coloured; the leaves are obovate, downy underneath; and on young trees from twelve to twenty-four inches long, and from eight to sixteen broad. The flowers are in panicles, small, white, and fragrant; the seeds are lens-shaped, in four-celled drupes. This tree abounds in the vast forests of Java, Ceylon, Malabar, and Coromandel, and especially in the empires of Birman and Pegu. The wood has by long experience been found to be the most useful in Asia. It is easily worked, and at the same time both strong and durable. It is considered superior to all others for ship-building, not even excepting the oak.

Calcutta and Madras derive all their supplies of wood for ship-building from the teak forests of Ava and Pegu. Some of the finest vessels that have ever arrived in the Thames have been of teak tree, built in Bengal. The tree was introduced to the British possessions by Lord Cornwallis, and is now planted with a view to timber in the mountainous parts of Bengal.

Besides its value as timber, the teak has great beauty as a tree. It is found more than two hundred feet high, and the stem, the branches, and the leaves, are all very imposing. On the banks of the river Irrawady, in the Birman empire, the teak forests are unrivalled; and they rise so far over the jungle or brushwood, by which tropical forests are usually rendered impenetrable, that they seem almost as if one forest were raised on gigantic poles over the top of another. The teak has not the broad strength of the oak, the cedar, and some other trees; but there is a grace in its form which they do not possess.

A specimen was introduced into the Royal gardens at Kew, about sixty years ago. It thrives in loam and peat, and ripe cuttings root freely in sand under a hand-glass; but from the warmth of the climate of which it is a native, it can never become a forest tree in this country.

MAGNOLIA. Natural family, *magnoliaceæ; polyandria, polygynia*, of Linnæus. The trees and shrubs which compose this family are, without exception, natives of Asia and America, where they are found nearly in the same latitude, being included within the 28th and 42d parallels. All the magnolias have beautiful foliage, and most of them large and splendid flowers. The species which are indigenous to North America, and particularly those which grow in the southern part of the United States, are in these respects the most remarkable; hence for more than half a century they have been highly esteemed in Europe as ornamental plants. In the climates of London and Paris, several of the Asiatic, and even of the American species, require shelter in winter to secure them from the frosts. Of thirteen species of this family, five belong to China and Japan. Of these, the magnolia yalan is the largest. It attains the height of forty to fifty feet; and its flowers, which are nearly six inches in diameter, diffuse a delicious odour. It has been cultivated for several centuries, and serves particularly for the embellishment of the emperor of China's garden. In Chinese poetry it figures as a symbol of beauty and candour. Of the eight remaining species one belongs to the West Indies, and seven to the United States.

THE BIG LAUREL *(magnolia grandiflora)*. Of all the trees of North America this is the most

167.

The Big Laurel.

remarkable for the majesty of its form, the magnificence of its foliage, and the beauty of its flowers. It is first seen in the lower part of North Carolina; proceeding from this point, it is found in the maritime parts of the southern states of the Floridas, and as far up as 300 miles above New Orleans.

Its ordinary stature is from sixty to seventy feet, although it sometimes grows as high as ninety. Its trunk is commonly straight, and its summit nearly in the shape of a regular pyramid. Its leaves are entire, oval, sometimes acuminate and sometimes obtuse at the summit, six to eight inches long, and borne by short petioles. They are evergreen, thick, coriaceous, and very brilliant on the upper surface. On trees which, for their beauty, have been left standing here and there in clearing the land, the foliage, upon being exposed to the sun, assumes a rusty ferruginous colour beneath. The flowers are white, from seven to eight inches in diameter, of an agreeable odour, and, on detached trees, they are very numerous. Blooming in the midst of rich foliage, they produce so fine an effect, says Michaux, that those who have seen the tree in its native soil agree in considering it as one of the most beautiful productions of the vegetable kingdom. The fruit is a fleshy oval cone, about four inches in length. It is composed of a great number of cells, which, at the age of maturity, open longitudinally, showing two or three seeds of a vivid red. The seeds soon after quit the cells, and for some days remain suspended without, each by a white filament attached to the bottom of its cell. The red pulpy substance which surrounds the stone decays and leaves it naked. The stone contains a white milky kernel.

In Carolina this tree blossoms in May, and its seeds are ripe about the beginning of October. The trunk is covered with a smooth grayish bark, resembling that of the beech. The wood is soft, and remarkable for its whiteness, which it preserves even after it is seasoned.

This tree grows only in cool and shady places, where the soil, composed of brown mould, is loose, deep, and fertile. These tracts lie contiguous to the great swamps which are found on the borders of the rivers, and in the midst of the pine barrens, or form themselves a part of these swamps; but they are never seen in the long and narrow marshes called branch swamps, which traverse the barrens in every direction, and in which the miry soil is shallow, with a bed of white quartz or sand beneath.

The seeds of the big laurel become rancid less speedily than those of the other magnolias. They may be kept several months before they are sown. A single tree sometimes yields 300 or 400 cones, each of which contains forty to fifty seeds.

The big laurel is deservedly esteemed in Europe by the cultivators of foreign plants. It is valued not only for the magnificence of its foliage and flowers, but also for its power of resisting cold. It is hardier than the orange tree, and in America grows five degrees farther north. Indeed, in some parts of the States, it stands winters which are much more severe than those of Paris or London.

THE SMALL MAGNOLIA, or WHITE BAY *(m. glauca)*. This tree, though inferior in size to the preceding, and less regularly formed, is yet very interesting on account of its beautiful foliage and flowers. It is found in the eastern and some of the middle states of America, and in the maritime parts of the southern states. It is one of the most abundant of the trees which grow in wet ground. It is not found to penetrate far into the interior of the country, and is unknown in the western states. In the lower parts of New Jersey and Pennsylvania, and farther south, it is seen only in the most miry swamps, which, during the greater part of the year, are so wet as to be impassable. Here it is accompanied by the white cedar, and by the different species of andromeda and whortle-berry. In the Carolinas and Georgia it grows abundantly in the long narrow marshes which traverse the pine barrens, on a black miry soil, which lies above a bed of sterile sand.

The leaves of the small magnolia are five to six inches long, petiolated, alternate, oblong, oval, and entire. They are of a dark shining green above, and glaucous underneath, thus presenting an agreeable contrast in the colour of the two surfaces. The leaves fall in the autumn, and re-appear early in spring. The flowers, which are single, and situated at the extremity of the branches, are two to three inches in breadth, white, and composed of several concave oval petals. In the southern states the blossoms appear in May; in the northern a month later. In the neighbourhood of New York and Philadelphia, they are collected and sold in the markets. The fruit is small, green, and conical, composed of a number of cellules, and varying in length from an inch to an inch and a half. When ripe, the seeds, which are of a scarlet colour, burst their cells, and remain some days suspended by white slender filaments. The seeds very speedily become rancid; and in order to preserve their germinating power, they must be placed as soon as gathered, and before the enveloping pulp is withered, in rotten wood, or in sand slightly moistened. The bark of the tree is smooth, and of a gray colour. The trunk is much bent, and divided into a great number of branches. The wood is of a white colour, light, and of no use. From its obtaining the name of "beaver wood," it is probable these animals at one time were inhabitants of the localities where it grows, and made use of it for constructing their dams. The bark and seed-cones have a bitter taste and aromatic flavour, and are used as tonics. This elegant tree stands the climate of Europe, and ripens its seeds in the environs of Paris.

THE CUCUMBER TREE *(magnolia acuminata)*. This is a beautiful tree, equal in height and diameter to the big laurel. It abounds along the whole mountainous tract of the Alleghanies, including a distance of 900 miles, and is also common on the Cumberland mountains. The situations peculiarly adapted to its growth are the declivities of mountains, narrow valleys, the banks of torrents, where the atmosphere is constantly moist, and where the soil is deep and fertile. The leaves are six to seven inches in length, and three or four inches broad upon old trees. Upon saplings, growing in moist places, they are sometimes double this size. They are oval, entire, acuminate, and deciduous. The flowers are five to six inches in diameter, of a blue colour, or sometimes white, with a tint of yellow, and a faint odour. As they are very numerous, they produce a pleasing effect amid the dark foliage. The cones are about three inches long, eight or ten lines in diameter, of nearly a cylindrical shape, and often a little larger at the upper end than at the base. On one side they are convex, and concave on the other, and when green, nearly resemble a young cucumber; hence the common name of the tree. The inhabitants in the neighbourhood of the Alleghanies steep these cones in spirits, and use the tincture as a tonic.

This tree sometimes exceeds eighty feet in height, and three or five feet in diameter. The trunk is straight and of a uniform size, and often destitute of branches for two-thirds of its height. The summit is ample, regularly shaped, and altogether forms one of the handsomest forms of foliage of any tree in America. The heart wood is soft, and of a yellowish brown colour, resembling that of the poplar or tulip tree. Like this wood, also, it is fine grained, and susceptible of a brilliant polish; but it is less strong and durable when exposed to the weather. Being not a very common tree, it is not much employed in the arts. Sawn into bands, it serves for joinery work in the interior of houses; and for its size and lightness it is selected for large canoes. It bears the winters of England, Germany, and France, and flourishes in the open fields.

The other species are the heart-leaved cucumber tree *(m. cordata)*, which is nearly similar, but smaller, and has yellow petals; the umbrella tree *(m. tripetala)*, with large leaves and flowers, but a tree of moderate size; and the long-leaved cucumber tree *(m. auriculata)*, with leaves eight to nine inches long, broad at the top, and acuminated and narrow and somewhat spear-shaped at the base. The flowers are large, white, and of an agreeable odour; the cones smaller than those of the other species, and of a red colour.

LOBLOLLY BAY *(gordonia lasyanthus)*. This tree grows to the height of fifty or sixty feet, with a diameter of eighteen to twenty inches. For twenty-five to thirty feet its trunk is perfectly straight. The leaves are evergreen, four to six inches long, alternate, oval, acuminate, and slightly toothed. The flowers are upwards of an

inch in breadth, white, and sweet scented, making their appearance about the middle of July, and blooming in succession for two or three months. The fruit is an oval capsule, with five segments, containing small black winged seeds. The wood is light, of a fine silky texture and rosy hue, brittle, and rapid in its decay when exposed to moisture. The bark is used in tanning.

Franklinia *(gordonia pubescens)*. This tree, which rarely exceeds thirty feet in height, is confined almost entirely to the banks of the Altamaha in the state of Georgia. The leaves are alternate, oblong, narrow at the base, and toothed; they are deciduous. The flower is five petaled, white, and, like those of the loblolly, they continue to blow in succession for two months. The shrub has long been cultivated in France and England, and is a beautiful ornamental plant, especially when the flowers are rendered double by culture.

The Tulip Tree *(liriodendron tulipifera)*. This tree which surpasses most others of North America in height, and in the beauty of its foliage and of its flowers, is also one of the most interesting from the numerous and useful applications of its wood. Throughout the States it is generally called poplar, or white wood, canon wood, and more rarely the tulip tree.

168.

Tulip Tree.

This tree is often seen eighty and one hundred feet in height, with a diameter from eighteen inches to three feet. In the development of its leaves it differs from most other trees. Leaf-buds in general are composed of scales closely applied one upon another, which in the spring are distended by the growth of the minute bundle of leaves which they enclose, till they finally fall. On some trees these buds are without scales. On the tulip tree the terminal bud of each shoot swells considerably before it gives birth to the leaf; it forms an oval sack, which contains the young leaf, and which produces it to the light only when it appears to have acquired sufficient force to endure the influence of the atmosphere. Within the sack is found another, which, after the first leaf is put forth, swells, bursts, and gives birth to a second. On young and vigorous trees, five or six leaves issue successively in this manner from one sack. Till the leaf has acquired half its growth, it retains the two lobes which composed its sack, and which are now called *stipulæ*. In the spring, when the weather is warm and humid, the growth of the leaves is very rapid. They are six to eight inches broad, borne on long petioles, alternate, somewhat fleshy, smooth, and of a pleasing green colour. They are divided into three lobes, of which the middle one is horizontally notched at its summit; the two lower ones are rounded at the base. This conformation is peculiar to the tulip tree, and renders it easily distinguishable in the summer. The flowers, which are large, brilliant, and, in detached trees, very numerous, are variegated with different colours, among which yellow predominates. They have an agreeable odour, and surrounded by luxuriant foliage they produce a very striking effect. In spring they are collected by females, and sold in the market of New York. The fruit is composed of a number of thin narrow scales, attached to a common axis, and forming a cone two or three inches in length. Each cone consists of sixty or seventy seeds, of which never more than a third, and in some seasons not more than seven or eight of the whole number are productive. It is also remarked, that for the first ten years after the tree has begun to yield fruit, the seeds are unproductive; and that in large trees the seeds from the highest branches are the best. The bark in young trees is smooth and even; in older trees it cracks, and separates into deep furrows. The heart or perfect wood is yellow, approaching to a lemon colour, and its alburnum is white. The wood is heavier than that of the poplars, and its grain equally fine and more compact. It is employed for various useful purposes in house building, coach pannels, trunks, &c. The bark, especially of the roots, has an aromatic smell and bitter taste; it has been used in medicine as a tonic and febrifuge.

The tulip tree has been introduced into Europe within the last century, where it thrives well, and bears abundance of flowers.

The Laurel *(laurus nobilis)*. Natural family *laurinæ; enneandria, monogynia*, of Linnæus. This common and beautiful evergreen is celebrated as the *laurus* of the Romans and the *daphne* of the Greeks, which was consecrated to priests and heroes, and used in their sacrifices. In the south of Italy it grows to a sufficient

height to be considered a tree; but is so prolific in suckers and low shoots as always to have the character of a shrub. It forms a dense and yet broken and picturesque mass of a very fine deep green, inclining to olive, and is abundantly covered with berries, which are dark purple, or black, when ripe. Oil is obtained from the latter by boiling water. Both the leaves and the berries have a sweet fragrant odour, and an aromatic astringent taste; and the oil, which is of a yellowish green colour, has a strong but similar odour and taste. Water distilled from the leaves is embued with prussic acid, and on this account becomes poisonous.

The Royal Bay *(l. indica)*, grows in the Canary islands and in Virginia. The wood is of a yellow colour, and rather light, and is used for buildings and for furniture. In Madeira it is called *vigmatico*, and is probably the same wood which is imported into England under the name of Madeira mahogany; indeed it is hardly to be distinguished from mahogany, only it is of a lighter colour. The Portuguese laurel, a common shrub in our gardens, we have already alluded to under the head of fruit trees, as it belongs to the same family as the plum and cherry. It is also a favourite evergreen, and possesses the same narcotic qualities as the laurels, prussic acid being contained in the leaves.

The Red Bay *(l. caroliniensis)*. This tree is found in the lower part of the state of Virginia, and in the Carolinas and Georgia, in which places it often rises to the height of sixty and seventy feet. The leaves and flowers bear a close resemblance to the common bay, and have the same peculiar odour when bruised. The wood is of a beautiful rose colour, is strong, and has a fine compact grain, and is susceptible of a beautiful polish. Before the general introduction of mahogany, this wood was much employed in the construction of furniture. It is now, when it can be procured, employed along with red cedar in ship building, for which purpose its strength and durability well fit it.

The Holly *(ilex)*. Natural family *rhamni; tetrandria, tetragynia*, of Linnæus. Of the holly there are sixteen species, and the varieties produced, distinguished chiefly by the leaves, are very numerous.

The Common Holly (ilex æquifolium), is very abundantly diffused, being found in warm climates and in cold, in most countries of Europe, and in many of Asia and America. Hollies are abundant in some of the uncultivated parts of the southern counties of England; and they are also to be met with in the Highlands of Scotland, in places where one could hardly suppose they had been planted.

Were it not that the holly grows very slowly when young, and cannot be safely transplanted when it has attained a considerable size, it would make better hedge-rows than the hawthorn. When allowed time, and not destroyed by shortening the top-shoot, the holly grows up to a large tree. Some at the Hollywalk, near Frensham, in Surrey, are mentioned by Bradley as having grown to the height of sixty feet; and old hollies of thirty and forty feet, with clean trunks of considerable diameter, are to be met with in many parts of the country.

A holly hedge is a pleasing object, though it is too often clipped into formal shapes. Evelyn had a magnificent hedge of this sort, at his gardens at Say's Court, which he planted at the suggestion of Peter the Great, who resided in his house when he worked in the dock-yards at Deptford. He thus rapturously speaks of this fine fence: "Is there under heaven a more glorious and refreshing object of the kind than an impregnable hedge, of about four hundred feet in length, nine feet high, and five in diameter, which I can show in my new raised gardens at Say's Court (thanks to the Czar of Muscovy), at any time of the year, glittering with its armed and varnished leaves, the taller standards, at orderly distances, blushing with their natural coral." The largest holly hedge in Scotland is at Tynningham, near Dunbar, planted by a former earl of Haddington, author of a treatise on fruit trees. It has for many years past been left uncut, and now presents a noble phalanx of deep shining green leaves, and numerous spiry tops, with spikes of coral berries.

The timber of the holly is very white and compact, which adapts it well for many purposes in the arts; though, as it is very retentive of its sap, and warps in consequence, it requires to be well dried and seasoned before being used. It takes a durable colour, black, or almost any other; and hence it is much used by cabinet-makers in forming what are technically called strings and borders in ornamental works. When properly stained black, its colour and lustre are not much inferior to those of ebony. For various purposes of the turner, and for the manufacture of what is called Tunbridge ware, it is also much used; and next to box and pear tree, it is the best wood for engraving upon, as it is close and stands the tool well. The slowness of its growth, however, renders it an expensive timber. The bark of the holly contains a great deal of viscid matter; and when macerated in water, fermented, and then separated from the fibres, it forms bird-lime.

Martin first discovered the difference of sexes in the holly, some being male, others female, and others hermaphrodite. It is a tree of great longevity, and will grow in any soil not very wet; but it thrives best in a dry deep loam. The holly is produced from seed. The berries being gathered in November, and mixed with sand in heaps, in the open garden, till they are divested

of the pulp, which process extends till the following autumn, are then sown in beds. In general they do not vegetate till the second year after they have been gathered. There are six or eight varieties of the common holly, chiefly marked by the size and form of the leaves; there are also about sixteen distinct species.

Box. Natural family *euphorbiaceæ; monœcia, tetrandria*, of Linnæus. The wood of the box is of considerable size, though we generally meet with small species in this country, in the state of a shrub, forming borders, where the largest stem is not thicker than a packthread; or, when not in this state, still as a little shrub often tastelessly cut into fantastic shapes. Only two species of box are mentioned by botanists; but there are several varieties, and one of them, the *dwarf box (buxus suffruticosa)*, ought, perhaps, to be considered as a distinct species from the *common box (buxus sempervirens)*, and not merely a variety, as no art has been able to rear the former to the size of the latter. The seeds of the one were never observed by Miller to produce plants of the other, as is the case with most varieties of species in the vegetable kingdom, more especially of trees and shrubs.

When allowed to arrive at its full growth, the box attains the height of twelve or fifteen feet, and the trunk varies in diameter from three to six inches, which it sometimes, though rarely, exceeds.

It is a native of all the middle and southern parts of Europe; and it is found in greater abundance and of a larger size in the countries on the west of Asia, to the south of the mountains of Caucasus. In many parts of France it is also plentiful, though generally in the character of a shrub. In early times it flourished upon many of the barren hills of England. Evelyn found it upon some of the higher hills in Surrey, displaying its myrtle-shaped leaves and its bright green in the depth of winter; and till very recently, it gave to Boxhill, in that county, the charms of a delightful and perennial verdure. The trees have now been destroyed, and the name, as at other places called after the box, has become the only monument of its former beauty.

Yet no tree so well merits cultivation, though its growth be slow. It is an unique among timber, and combines qualities which are not found existing together in any other. It is as close and heavy as ebony; not very much softer than *lignumvitæ;* it cuts better than any other wood; and when an edge is made of the ends of the fibres, it stands better than lead or tin, nay almost as well as brass. Like holly, the box is very retentive of its sap, and warps when not properly dried, though, when sufficiently seasoned, it stands well. Hence, for the wooden part of the finer tools, for every thing that requires strength, beauty, and polish in timber, there is nothing equal to it. There is one purpose for which box, and box alone, is properly adapted, and that is the forming of wood-cuts, for scientific or other illustrations in books. These reduce the price considerably in the first engraving, and also in the printing; while the woodcut in box admits of as high and sharp a finish as any metal, and takes the ink much better. It is remarkably durable too; for if the cut be not exposed to alternate moisture or heat, so as to warp or crush it, the number of thousands that it will print is almost incredible. England is the country where this economical mode of illustration is performed in the greatest perfection; and just when a constant demand for box was thus created, the trees available for the purpose had vanished from the island.

Permanent figures and ornaments are often impressed upon box, by a much more cheap and simple process than that of carving. For this purpose the wood is softened by the application of heat and moisture; and the die being strongly pressed upon it when in that state, the impression comes off, and is retained with considerable sharpness. Snuff-boxes of this description are extensively made in France, Switzerland, and Germany, and the material used is principally the root of the box.

Animals have an aversion to the leaves and seeds of the box; and the honey from the flowers was supposed by the ancients to have a poisonous quality.

CHAP. XLIV.

THE CONIFERÆ, OR PINE TRIBE—THE PINE, FIR, LARCH, CYPRESS, &c.

This very important tribe of trees is comprehended under a very well marked natural family, the *coniferæ*, belonging chiefly to the class *monœcia, polyandria*, of Linnæus. They are all evergreens, with the exception of the larch and gingo. The leaves are stiff and coriaceous, generally linear, and collected in bundles of from two to five, accompanied at the base by a small sheath. The flowers are unisexual, and generally disposed in cones or catkins. The male flowers consist essentially each of a stamen, either naked or accompanied by a scale in the axilla; not unfrequently several stamina are united together by their filaments. The female flowers vary much; the general form is that of a cone or scaly catkin. The cotyledons of the seed vary from two, three, four, and even as many as ten.

The greater number of the species are tall and lofty trees, and they all yield an essential oil, well known as turpentine, and resin, or gum. The seeds contain a bland oil, and those of some

of the species are eaten as nuts. They are chiefly natives of the northern, temperate, and arctic regions, a few only being found in the southern hemisphere.

The family has been divided into thirteen genera, containing a considerable number of species. The genera are:—

Pinus, the Fir.
Abies, Spruce.
Larix, Larch.
Shubertia, Deciduous Cypress.
Cupressis, Cypress.
Thujà, Arbor Vitæ.
Juniperus, Juniper.
Araucaria, New Holland Pine.
Belis, Javelin-shaped.
Agathus, Dammer Pine.
Exocarpus, Cypress-like.
Podocarpus, Chinese Pine.
Taxus, Yew.

THE PINE *(pinus)*. This name is of Celtic origin, and is the same in all the dialects of that tongue. Pin, or pen, signifies a rock or mountain, the chief favourite locality of this tribe of trees.

Although in all, or most of its species, inferior to the oak in the strength or the durability of its timber, the pine, perhaps, claims the second place among valuable trees. It is very abundant, its growth is comparatively rapid, and its wood is straight, elastic, and easily worked. Accordingly, as oak is the chief timber in building ships for the sea, pine is the principal one in the construction of houses upon land. It is "the builder's timber:" and as, when the carpenter wants a post or a beam of peculiar strength and durability, he has recourse to the oak; so when the shipwright wishes to have a piece of timber that shall combine lightness with great length, as for a spar or mast, he makes use of the pine.

The distinct species of pines enumerated by botanists are upwards of twenty. None of these bear flat leaves, but a sort of spines, which, however, are true leaves. They are mostly evergreens; but the appearance of the tree, as well as the quality of the timber, varies with the species, as also with the situation in which it grows. Generally speaking, the timber is the more hard and durable the colder the situation, and the slower the tree grows; and in peculiar positions it is not unusual to find the northern half of a common pine hard and red, while the southern half, though considerably thicker from the pith to the bark, is white, soft, and spungy.

No account can be given of the first use of the different species of pines by the natives of the countries where they are indigenous. The cedar of Lebanon appears to have been used from the earliest periods of Syrian history. The Romans, and after them the Venetians, made use of the larch for architectural and household purposes, as well as in the construction of their galleys and vessels. The Norwegians and Danes constructed their first ships of the pines of the Scandinavian mountains. Upon the Gulph of Bothnia, near the borders of Lapland, at the bottom of one of the forests sloping towards a bay, Dr Clarke saw a pine vessel of forty-six tons, just launched, which had been built by the natives upon one of the wildest scenes of the coast, without the aid of docks, or any other convenience required by marine architects. The people of the northern parts of Britain still make their boats, and the rudest of them even their cordage, of the pine; and though the timber of the pines of the New World be, upon the whole, less hard and durable than those of Europe, it is employed for ship building, as well as for domestic purposes. The pine found in the bogs of Ireland is of a very superior quality, and used by the inhabitants for many purposes. Some persons of rank in that country have halls and other apartments floored with bog-pine; while, in several districts, it is the only timber of the peasants, who make of it their wooden utensils, and also their cordage. It is perfectly proof against the worm; and seems, in durability, almost to rival the cedar itself. From the greater ease with which it can be worked, and its aptitude to receive and retain paint, pine is now chiefly employed in the roofs, floors, and internal finishing of houses;—the European sort, where it has to bear a strain, or is exposed to wearing,—and the softer kinds, from America, for internal mouldings and ornaments.

As is the case now with a great part of Canada, Norway, Sweden, the eastern shore of the Baltic, and some considerable tracts of the Highlands of Scotland, it is probable that, in very early ages, great part of Britain, with those islands towards the north, in which there is now hardly a shrub of any kind, were covered by pine forests. There has been much controversy amongst the learned whether the pine was indigenous to England. Cæsar expressly says that Britain had all the trees of Gaul, except the beech and fir. It is remarkable, however, that our names for the beech are derived from the Roman word *fagus;* but the fir has three names, which are purely British—this would seem to justify the conclusion, that the tree was not introduced by the Romans, but was originally British. The fir is perpetually discovered in such of our mosses as were certainly prior to the time of the Romans; remains of the tree have been found, not only on the sides of Roman roads, but actually under them. But a more complete proof of the ancient existence of pine forests in England has been afforded by a minute examination of an extensive district called Hatfield Chase, in Yorkshire. This curious subject was investigated with great diligence by the Rev. A. De la Pryme, and the

results of his researches were communicated to the Royal Society, in a paper published in their Transactions for 1701.

The famous levels of Hatfield Chase were the largest chase of red deer that king Charles the First had in England, containing in all above 180,000 acres of land, about half of which was yearly drowned by vast quantities of water. This being sold to one Sir Cornelius Vermuiden, a Dutchman, he at length effectually dischased, drained, and reduced it to constant arable and pasture grounds, with immense labour, and at the expense of above £400,000. In the soil of all or most of these 180,000 acres of land, of which 90,000 were drained, even in the bottom of the river Ouse, and in the bottom of the adventitious soil of all marshland, and round about by the skirts of the Lincolnshire Wolds, unto Gainsbury, Bawtry, Doncaster, Baln, Snaith, and Holden, are found vast multitudes of the roots and trunks of trees, of all sizes, great and small, and of most of the sorts which this island either formerly did, or at present does, produce; as fir, oak, birch, beech, yew, thorn, willow, ash, &c., the roots of all or most of which stand in the soil in their natural position, as thick as ever they could grow, as the trunks of most of them lie by their proper roots. Most of the large trees lie along about a yard from their roots (to which they evidently belonged, both by their situation and the sameness of the wood), with their tops commonly north-east, though, indeed, the smaller trees lie almost every way, across the former, some over, and others under them; a third part of all being pitch trees, or firs, some of which are thirty yards in length or upwards, and sold for masts and keels of ships. Oaks have been found of twenty, thirty, and thirty-five yards long, yet wanting many yards at the small end; they are as black as ebony, and very durable in any service they are put to. It is very observable, and manifestly evident, that many of those trees of all sorts have been burnt, but especially the pitch or fir trees, some quite through, and some all on a side; some have been found chopped and squared, some bored, others half split, with large wooden wedges and stones in them, and broken axe heads, somewhat like sacrificing axes in shape; and all this in such places and at such depths that they could never have been opened since the destruction of this forest till the time of the drainage. Near a large root, in the parish of Hatfield, were found eight or nine coins of some of the Roman emperors, but exceedingly consumed and defaced with time; and it is very observable, that on the confines of this low country, between Burningham and Brumby in Lincolnshire, are several great hills of loose sand, under which, as they are yearly worn and blown away, are discovered many roots of large firs, with the marks of the axe as fresh upon them as if they had been cut down only a few weeks. Hazel-nuts and acorns have frequently been found at the bottom of the soil of those levels and moors, and whole bushes of fir tree apples, or cones, in large quantities together.

The author of this paper then goes on to show that the Romans destroyed this immense forest, partly by cutting down the trees, and partly by burning them; and that these fallen trees dammed up the rivers, which, forming a lake, gave origin to the large turf moors of that part of the country. The Romans themselves mention cutting down the British forests, as well for the purpose of making roads through the country, as to drive the natives out of their fastnesses.

In the peat-bogs of the bleakest districts of Scotland, the remains of pine trees are very abundant; and such is their durability, in consequence of the quantity of turpentine they contain, that, where the birch is reduced to a pulp, and the oak cracks into splinters, as it dries, the heart of the pine remains fresh, and, embalmed in its own turpentine, is quite elastic, and used by the country people in place of candles. In England, too, subterraneous beds of pines have been found; and though, in consequence of the greater warmth of the climate, these contain less turpentine, and are more decayed, the remains of the cones, or seed-vessels, show that they belong to the same species.

The Wild or Scotch Pine (pinus silvestris), commonly, though erroneously, called the Scotch fir, is a very widely diffused tree. There can be no doubt but that it is indigenous to Scotland. It is found growing in a state of nature in many situations; and the native forests of Invercauld and Rothiemurchus exhibit the finest specimens of this tree in Britain. It is also indigenous in the Alps, in the north of Germany, in Sweden and Norway, and in Russia. The pine in favourable situations attains the height of eighty feet, and from four to five feet in diameter. The trunk is covered with a thick and deeply furrowed bark; the leaves are in pairs, of a pale green colour, stiff, twisted, and about three inches long; the flowers are of a yellowish tint, and the cones are grayish, of a middling thickness, and a little shorter than the leaves. Each scale is surmounted by a retorted spine. The seeds are small, black, and garnished with a reddish wing; they ripen the second year. The timber is called red or yellow deal, and is the most durable and valuable of the whole genus, with the exception of the larch, which is also very durable.

169.

Scotch Pine.

The timber produced in the cold elevated situ-

ation of the north of Scotland is found not inferior to any imported from Norway; but that which has been planted and reared in the low districts is not nearly so durable. There are several varieties of this pine. According to Sang, the variety cultivated is least worth the trouble. The *p. silvestris*, variety *montana*, he says, is that which yields the red wood; even young trees of this sort are said to become red in their wood and full of resin very soon. The late Mr Don of Forfar exhibited specimens of cones of each variety to the Highland Society of Scotland. The variety preferred by him is distinguished by the disposition of its branches, which are remarkable for their horizontal direction, and for a tendency to bend downwards close to the trunk. The leaves are broader and shorter than in the common kind, and are distinguished at a distance by their much lighter and beautiful glaucous appearance. The bark of the trunk is smoother than in the common kind; the cones are thicker, and not so much pointed. The plant is also more hardy, grows freely in almost any soil, and quickly arrives at a considerable size.

Pines generally are found growing in forests, or clustered together. In this position they grow tall and upright, with few lateral branches, except near the top. Growing singly, however, they branch out into a broad spreading tree, and have certainly a more picturesque appearance than when in the other position.

With the exception of cedar and larch, in respect of toughness and durability, Scotch fir produces better timber than any of the pines. It is good, too, almost in proportion to the slowness of its growth. When it is cut directly to the centre, or right across the grain, as for breasts of violins, and the sounding-boards of other musical instruments, it is very beautiful, the little stripes formed by the annual layers being small and delicate, and in perfectly straight lines. This pine very often, though not in trees completely matured, contains sap-wood next the bark; and toward the pith it is a little spongy. The best part is that nearest the root; and the roots themselves are excellent for any purpose that their size and shape will answer. It has been mentioned, that the best pine timber is that grown in cold situations; it is also best on light soils, and when planted by nature. On strong clay it will not thrive, and the timber is worth little; and on rich loams, though it grows rapidly, the timber is of inferior quality, and contains a great deal of sap-wood. At what time the sap-wood changes to durable wood has not been determined by very accurate observation; although most writers on vegetable physiology conceive that the ligneous matter is deposited in the second year. This, however, depends on circumstance; sometimes the alburnum remains soft for four or five years.

Pines, and especially the Scotch pine, occur in much more extensive forests, and with a far less admixture of other trees, than any other genus whatever. Immense districts in North America are covered with them; and so are the mountains of Sweden and Norway, and the sandy tracts near the Baltic. In Poland also, upon each side of the river Memel, they grow in great abundance, and Memel fir is imported into this country in large quantities.

Though the pine is not the timber that we last meet with on the confines of the snow, as we ascend high mountains, or at the verge of vegetation as we approach the pole, yet, after a certain elevation, and north of the latitude of about 55°, it is by far the most abundant timber, in Europe, in America, and in Asia. From the peculiar nature of the surface in Siberia,—the country which occupies the north of Asia,—from the intense cold, and lowness of the portion next to the sea, the forests in that part of the world are not very extensive, till we arrive at some distance from the Arctic ocean. In America, too, there are extensive naked tracts between the sea, and the unexplored country to the northward. But, from the summit of the ridge that extends from the dreary shores of Labrador westward, across the country, till it subsides in the central marshes about lake Winnipec, and on the south side of the vast estuary of the St Lawrence, as far as the boundary of the United States, the land, before it began to be cleared by European settlers, was covered by one immense forest of pine; and much of the clearing has been accomplished by burning, or otherwise destroying the trees. On the south side of the St Lawrence, the forest reached down to the water along the whole shore, and upon the islands; and advantage has been taken of this to send a great quantity of the most accessible of the timber to the European market, and to distil into tar a good deal of that which was not so accessible.

The pine forests of the north of Europe are, however, the most valuable, especially on account of the quality of their timber. Once they abounded over the greater part both of the continent and the islands; but in the latter situations they have been exhausted somewhat wantonly. Not much more than a century, or a century and a half ago, there was an extensive pine forest in the north of Ireland, in that elevated part of the country which extends through the counties of Donegal and Tyrone, and separates the rivers that flow to the sea on the north, from those that flow south and east to Loughs Earn and Neagh. Hardly a vestige of that forest now remains, nor is there any very clear account of what became of it.

In the lowlands and rich soils of Scotland, there perhaps never was an extensive pine forest;

but there can be little doubt that upon the uplands the pine was once as general as it now is in the back settlements of Upper Canada. Of these forests many vestiges still remain. The fragment which lies farthest to the south-west, is that of Rannoch, on the confines of the shires of Perth, Inverness, and Argyle. The greater part of that forest has, however, been felled, and the timber was floated down the Tummel and the Tay, for a distance of at least sixty miles to Perth, from Rannoch. The roots that remain bleaching on the surface, and the occasional trees that are still found in sheltered situations, or in situations which are not accessible, afford evidence that the forest once extended eastward not only to the remaining woods of Mar, at the sources of the Dee and the Don, in the west part of Aberdeenshire, but to the shore of the sea along that bleak ridge in the northern part of the county of Mearns, which forms the southern boundary of the valley of the Dee, and in the very extensive peat moss, upon which pine is the submerged timber almost exclusively found. Further to the north, the pine forest appears once to have reached much nearer to the sea; though in the lowlands of the shires of Aberdeen and Moray, the chief evidence of it now is in the peat mosses or bogs: in these, however, it is abundant—so much so, that it forms an article of commerce, not only in the villages near which it is found, but in the city of Aberdeen. The sapwood is altogether gone; and, indeed, the principal remains are roots; but they contain a vast quantity of resin and turpentine: this renders them much superior to any other wood for kindling fires; and in the country districts slips of them are used as a substitute for candles.

Along the shores of the Moray Firth, no remains of the forest are found above ground, on the slopes of the mountains that are nearest to the sea; but at what may be considered as the highest summit of the Grampians, amidst the immense mountains of Cairngorm, Brae Riach, and Ben-mhuic-dhu, there are very extensive forests in the glens or valleys of the rivers that flow northward to the Spey. The estate of Rothiemurchus, in that part of Scotland, consists almost exclusively of natural pine forests. In places where it can be removed, the timber of this forest is of great value, and forms the chief revenue of the proprietor of the estate. The surface has, generally speaking, a northern aspect; and, in consequence of the very high mountains which lie to the south, with at least some part of their summits covered with perpetual snow, the climate is very cold, so that the pine of Rothiemurchus is full of turpentine, and is of excellent quality. A considerable portion of the pine which is in the most accessible places has been cut down; but, differing from many other parts of Scotland, a succession springs up, and that forest appears to have still the power of continuing itself, and is, perhaps, the only pine forest in the island which has that power.

The Rothiemurchus pine is generally floated down the river Spey; and when it is once brought to that river, the passage of a raft is a matter of little difficulty at any season. In times of drought there is, however, a good deal of difficulty in getting the timber to the Spey; and, in order to accomplish that object, the workmen collect the trees in the *dell*, or den, build up a temporary dam, and wait the coming of a flood, which, in a country of so varied surface, is of frequent occurrence. When the flood comes, and the temporary dam is full of water, they break down the dyke, and away go the whole contents, thundering down to the Spey.*

On the hills to the northward of the Spey, and just opposite to Rothiemurchus, there is a good deal of timber on the banks of the Dulnan; but in that part of the country the forest is decreasing. The timber there, however, is of good quality, though, perhaps, not altogether equal to that of Rothiemurchus.

The principal rivers by which timber is floated to the sea from the remains of the *Sylva Caledoniæ*, or Great Scottish Forest, beside the Tay and Spey, as has been mentioned, and the Dee, by which the timber of Mar is floated to Aberdeen, are the Ness and the Beauly, both in Inverness-shire. The pines on the Ness are to a considerable extent exhausted; and the trees that are now found in the remote places are, when cut, thrown into the small rivers, and float to Loch Ness. On the Beauly the forests are more extensive; and there are regular saw mills about midway between the forest and the sea, at which the trees are cut into scantlings. To the mills the trees float down the river; and at one place they have to descend a cascade of at least forty feet in height. This they sometimes do with so much violence, that they are split to threads. In that place, too, they have recourse to an artificial dam; but the dam is made of the trees themselves, which are left in a heap till the swelling of the river carries them away. Pines have not been found in Scotland at an elevation of more than 1500 or 2000 feet; and at even less than that, they are very stunted, if not sheltered in the ravines.

The immense Scandinavian forest, which occupies the slopes of the mountains, and banks of the rivers and arms of the sea, in all the central parts of Sweden and Norway, is one of the most considerable on the Continent. This forest consists for the most part of Scotch fir and spruce, the former yielding red or yellow deal, and the latter white. In very many places, both on the Swedish and the Norwegian side of the moun-

* Library of Entertaining Knowledge.

tains, these forests are not accessible; and they are of value only when situated near the banks of a lake, an arm of the sea, or a river.

Dr Clarke gives the following account of the extent of the pine forests on the Swedish side of the Gulph of Bothnia:

"At Helsinborg, some fir trees of an astonishing length were conducted, by wheel-axes, to the water side. A separate vehicle was employed for each tree, being drawn by horses which were driven by women. These long, white, and taper shafts of deal timber, divested of their bark, afforded the first specimens of the produce of those boundless forests of which we had then formed no conception. That the reader may therefore be better prepared than we were for the tract of country we are now to survey, it may be proper to state, in the way of anticipation, that if he cast his eyes upon the map of Sweden, and imagine the gulf of Bothnia to be surrounded by one contiguous unbroken forest, as ancient as the world, consisting principally of pine trees, with a few mingling birch and juniper trees, he will have a general and tolerably correct notion of the real appearance of the country. If the sovereigns of the Europe were to be designated each by some title characteristic of the nature of their dominions, we might call the Swedish monarch *Lord of the Woods*, because, in surveying his territories, he might travel over a great part of his kingdom, from sun-rise until sun-set, and find no other subjects than the trees of his forests. The population is everywhere small, because the whole country is covered with wood; yet, in the nonsense that has been written about the *Northern hive*, whose swarms spread such consternation in the second century before Christ, it has been usual to maintain that vast armies issued from this land. The only region with which Sweden can properly be compared is North America, a land of wood and iron, with very few inhabitants, 'and out of whose hills thou mayest dig brass;' but, like America, it is also as to society in a state of infancy."

Except that the mountains are of less elevation, and that the climate is more moist, the eastern side of the gulph of Bothnia does not differ much from the western, as described by Dr Clarke.

The coast of Norway is more wild than that of Sweden, and the temperature is warmer in the same latitude, so that the pine forests extend rather farther to the north. Spruce is hardly found within the Arctic circle, but Scotch fir continues for nearly a degree more, even at considerable heights; and beyond that, straggling trees are to be met with in very sheltered places. The summit of the mountains on the north of the gulph of Bothnia may be taken as the limit of the Scandinavian pines, as from thence to North Cape there is nothing to be met with but dwarf birch.

The principal rivers by which the pines of the Scandinavian mountains are brought to the sea, westward, for the purposes of commerce, are the Gotha in Sweden, and the Glomm in Norway.

The Gotha issues from the large lake of Wener, in the centre of the southern part of Sweden; and the lake receives many streams from the mountains, some of which are of great length, and pass through forests of the finest pines. By means of these the pine trees are easily conveyed to the lake, and thence by the Gotha to Gottenburgh. In former times, the timber was allowed to float down the cataract of Trollhætta, by which many of the trees were spoiled, as there is a succession of falls, and some of them as high as thirty feet. Saw-mills are now erected at Trollhætta, and the timber is conveyed to the river farther down, by a canal. The timber of the south of Norway is brought by the Glomm to the bay of Christiana, where a great quantity is exported. Dr Clarke thus describes the process of sawing timber on the banks of the Dal, westward of the gulph of Bothnia; and we believe it does not vary much all over Scandinavia:

"Between Meheda and Elfskarleby, about two English miles before we reached the latter place, we were gratified by a sight of some cataracts of the *Dal*, which we thought far superior to those of *Trollhætta*. The display of colours in the roaring torrent was exceedingly fine; rushing with a headlong force, it fell in many directions, and made the ground tremble with its impetuosity. The height of the fall is not forty feet, but the whole river being precipitated among dark, projecting rocks, gives it a grand effect; a swelling surf continues foaming all the way to a bridge, where another cataract, meeting the raging tide, adds greatly to its fury. Such is the commotion excited, that a white mist, rising above the fall, and over the banks of the torrent, rendered it conspicuous long before we reached the river. Close to the principal cataract stood a sawing-mill, worked by an overshot wheel, so situate as to be kept in motion by a stream of water diverted from its channel for this purpose. The remarkable situation of the sawing-mills, by the different cataracts, both in Sweden and Norway, are among the most extraordinary sights a traveller meets with. The mill here was as rude and as picturesque an object as it is possible to imagine. It was built with the unplaned trunks of large fir trees, as if brought down and heaped together by the force of the river. The saws are fixed in sets, parallel to each other; the spaces between them in each set being adapted to the intended thickness for the planks. A whole tree is thus divided into planks, by a simultaneous operation, in the same time that a

single plank would be cut by one of the saws. We found that ten planks, each ten feet in length, were sawed in five minutes, one set of saws working through two feet of timber in a single minute. A ladder, sloping from the mill into the midst of the cataract, rested there upon a rock, which enabled us to take a station in the midst of the roaring waters. On all sides of the cataract, close to its fall, and high above it and far below it, and in the midst of the turbulent flood, tall pines waved their shadowy branches, wet with the rising dews. Some of these trees were actually thriving upon naked rocks, from which the dashing foam of the torrent was spreading in wide sheets of spray."

In some parts of Sweden there are accidental fires, and the pines are also sometimes burned, in order to clear the soil for agriculture. In the acount of his journey from Stockholm, northward, Dr Clarke says, "As we proceeded to Hamrange, we passed through noble avenues of trees, and saw some fine lakes on either side of the road. Some of the forests had been burned, by which the land was cleared for cultivation. The burning of a forest is a very common event in this country; but it is most frequent towards the north of the gulph of Bothnia. Sometimes a considerable part of the horizon glares with a fiery redness, owing to the conflagration of a whole district, which, for many leagues in extent, has been rendered a prey to the devouring flames. The cause is frequently attributed to lightning; but it may be otherwise explained; and we shall have to notice some remarkable instances of these fires in the sequel."

Again, Dr Clark mentions that in Lapland, beyond Tornea, "some forests were on fire near the river, and had been burning for a considerable time. Mr Tipping informed us, that these fires were owing to the carelessness of the Laplanders and boatmen on the rivers, who, using the *boletus igniarius* (German tinder) for kindling their tobacco pipes, suffer it to fall in an ignited state among the dry leaves and moss. They also leave large fires burning in the midst of the woods, which they have kindled to drive away the mosquitoesfrom their cattle and from themselves; therefore, the conflagration of a forest, however extensively the flames may rage, is easily explained. Yet Linnæus, with all his knowledge of the country and customs of the inhabitants, attributed the burning of the forests in the north of Sweden to the effects of lightning. During these tremendous fires, the bears, wolves, and foxes are driven from their retreats, and make terrible depredations among the cattle. A bear, having crossed the river, about a fortnight before we arrived, had killed in one night six cows and twelve sheep, the property of a farmer. We saw their former owner, and the place where all this slaughter had been committed, having landed to walk by the side of the river, while our boatmen were engaged in forcing the rapids. The farmer attributed his loss to the burning of the opposite forest, which had compelled the bear to pass the river for food."

On the southern shores of the Baltic there are also extensive pine forests. These are chiefly situated to the east of the Vistula, on the whole of the sandy tract that lies between the rich corn valley of that river and the flax and hemp valley of the Dwina, and stretches back into the central parts of Russia. The soil upon which this forest grows is almost wholly sand, and the surface is in consequence comparatively level, nor does any of it lie at a great elevation above the sea. The river Memel is the principal channel by which this timber is conducted to the sea, and Memel is the port at which it is chiefly disposed of. Much of the timber of Memel is exported in logs that are only squared by the axe; and masts and spars of Memel timber aie much esteemed. In the *haafs* or low lands on those shores of the Baltic, amber is found in greater abundance than in any other part of the world; and it is considered that it may be the turpentine of decayed pines changed by the length of time it has been buried in the earth.

The northern slopes of the Alps, and the secondary mountains in the south of Germany, abound in pines; and the Rhine and Danube (the principal upper branches of the latter rise in the Alps) are well adapted for conveying the timber to the lower districts, where it is valuable. The mode of conveying the timber on the Rhine, in immense rafts, is very curious. The following account of these rafts is by the author of "An Autumn near the Rhine:"—

"A little below Andernach, the little village of Namedy appears on the left bank, under a wooded mountain. The Rhine here forms a little bay, where the pilots are accustomed to unite together the small rafts of timber floated down the tributary rivers into the Rhine, and to construct enormous floats, which are navigated to Dortrecht, and sold. These machines have the appearance of a floating village, composed of twelve or fifteen little wooden huts, on a large platform of oak and deal timber. They are frequently eight or nine hundred feet long, and sixty or seventy in breadth. The rowers and workmen sometimes amount to seven or eight hundred, superintended by pilots and a proprietor, whose habitation is superior in size and elegance to the rest. The raft is composed of several layers of trees, placed one on the other, and tied together. A large raft draws not less than six or seven feet of water. Several smaller ones are attached to it by way of protection, besides a string of boats, loaded with anchors and cables, and used for the purpose of sounding the river and going on shore. The domestic

economy of an East Indiaman is hardly more complete. Poultry, pigs, and other animals, are to be found on board, and several butchers are attached to the suite. A well supplied boiler is at work night and day in the kitchen. The dinner hour is announced by a basket stuck on a pole, at which signal the pilot gives the word of command, and the workmen run from all quarters to receive their messes. The consumption of provisions in the voyage to Holland is almost incredible, sometimes amounting to forty or fifty thousand pounds of bread, eighteen or twenty thousand of fresh, besides a quantity of salted meat, and butter, vegetables, &c., in proportion. The expenses are so great, that a capital of three or four hundred thousand florins (about £35,000) is considered necessary to undertake a raft. Their navigation is a matter of considerable skill, owing to the abrupt windings, the rocks, and shallows of the river; and some years ago the secret was thought to be monopolized by a boatman of Rüdesheim and his son."

These rafts are not of modern invention, and are not confined to Europe. Evelyn, on the authority of Le Comte, says, that the timber merchants of China transport immense trees or floats, upon which they build huts and little cottages, where they live with their families.

The following passage from Planché's "Descent of the Danube," gives a description of the method of floating timber on a branch of that river; and the practice appears to be common in Germany:

"At the mouth of the Erlaf is a Rechen or Grate, where the wood collects that is floated down this stream from the forests in the neighbourhood of Maria-Zell, in the Steyermark, near which it takes its rise. It is customary in Germany to place one of these gratings at the mouth of any tributary stream, or in the bed of any river where a line of demarcation is drawn naturally or artificially between two kingdoms, two provinces, or even two parishes; so that the branches and trunks of trees blown down by high winds, and swept away by inundations into the current, should not be carried beyond the frontiers, or boundaries, of the state or property to which they belong, and which derives from them no inconsiderable portion of its revenue.

"The timber, also, regularly felled by the woodcutters is thrown thus carelessly on the mountain-streams of Germany, and floats down to the Rechen or Grate, where it is afterwards collected by its owners, who are thus saved the trouble and expense of land carriage; and the drifting property is protected from plunder by the severity of the laws relating to it."

In many parts even of Europe, the timber of pine forests is useless for purposes of commerce, from their inaccessible situations, and the consequent difficulty of transport. The rugged flanks and deep gorges of Mount Pilatus, in Switzerland, for instance, had been covered with impenetrable forests for many centuries, till an enterprizing individual conceived the daring idea of conveying the pines from the top of the mountain to the lake of Lucerne, a distance of nearly nine miles, by means of an inclined plane, extending the whole distance. This extraordinary contrivance, which was completed in 1812, became an object of wonder to all Europe, and was called the Slide of Alpnach, from the name of the Commune in which it was situated. The Slide was a trough, formed of 25,000 pine trees, six feet broad, and from three to six feet deep; this was kept moist. Its length was 44,000 English feet. It had to be conducted in an undeviating line over the summits of rocks, or along their sides, or under ground, or over deep gorges, where it was sustained by scaffoldings; and thus innumerable difficulties presented themselves in its construction. The perseverance of the engineer, M. Rupp, overcame all obstacles; and in eighteen months his work was finished. The trees descended from the mountain into the lake with an incredible rapidity. The larger pines, which were about one hundred feet long, ran through the space of eight miles and a third in about six minutes. A gentleman who saw this great work states, that such was the velocity with which a tree of the largest size passed any given point, that he could only strike it once with a stick as it rushed by, however quickly he attempted to repeat the blow. The markets of the Baltic being opened by the peace, the speculation was abandoned as unprofitable; and the Slide of Alpnach fell into ruin.

All the species of the pine, fir, and larch families, with the exception of one or two, as yet rare in this country, are raised from seeds. The cones are gathered in the winter season, and exposed to the sun, or to a gentle heat on a kiln, in order to facilitate the separation of the seeds. The cones of the cedar should be kept for a year at least after they are taken from the tree, before the seed be attempted to be taken out. This is necessary on account of the soft nature of the seeds, and the great quantity of resinous matter which the cones contain when growing, and which is discharged by keeping. Cedar cones are generally imported from the Levant, and the seeds retain their vegetative powers for many years. The cones of the Scotch pine, spruce, and larch, are the principal kinds which are opened by kiln heat. The cones of the Weymouth pine, silver fir, and balm of Gilead fir, give out their seeds with very little trouble. April is the best season for sowing all the species. The soil should be soft and rich, well mellowed by the preceding winter's frost and snow, carefully dried, and raked as finely as possible. The rarer sorts are generally sown in pots; but the more common in beds. The seed of the Scotch pine

and pinaster require a covering of half an inch in depth, those of the Weymouth pine three quarters of an inch, and those of the stone pine an inch and a quarter. The cedar is generally sown in broad pots, or boxes of light sandy loam, and covered half an inch. The seeds of the larch require a covering of only a quarter of an inch, those of the spruce fir an inch, those of the silver fir and balm of Gilead, from a half to three quarters of an inch. The seeds of the American spruce fir are smaller than any of the preceding, and therefore require a lighter covering. The strictest attention is required, both as to quality of soil and thickness of covering the seed, for though resinous trees are extremely hardy when grown up, yet they are all very tender in infancy.

The pine, fir, and larch families, benefit less by transplanting in the nursery than the non-resinous trees; and in general, when circumstances admit, the better plan is to remove them at once from the seed-bed, at two years old, to where they are finally to remain. The more delicate species, including the cedar and most of the pines, are best transplanted into pots, unless they can be placed at once where they are to remain. The more common pines and firs are transplanted, at two years of age, into nursery beds about the middle of April, for all the tribes, excepting the larch, which, being deciduous, should be transplanted in February. No description of tree plants receive so much injury as this tribe from the loss of roots, from the roots being exposed to the air, by being kept long out of the soil, or from compression, and exclusion of air and moisture, by being kept in close bundles or thick layers. They should, therefore, be finally planted as soon as possible after removal from the nursery, and, indeed, wherever it is practicable, no more should be taken up in one day than can be planted that day or the next. Nor are any plants more easily deprived of the vital principle by packing and carriage, either by sea or land, though, being all evergreens, excepting the larch, they do not readily show it. This fact, says Loudon, has been stated to us by experienced planters in Wales and different parts of England as the reason why so few trees are finally produced from the immense numbers of Scotch pine and larch fir annually sent to the south by the Scotch nurserymen.

The Scotch pine being the hardiest of all the sorts, and affording the most useful wood, is of course the most desirable for all rocky, sandy, and otherwise barren soils. The young trees are generally planted about four feet apart, and irregularly, not in rows. They are planted by taking up a turf, digging out two or three spadefuls of earth, and then depositing the plant along with the earth and the turf; or they may be planted, according to other directions, simply by a dibble hole in the soil. After planting, the only care necessary for several years is protection from cattle and hares, rabbits, and other vermin. In about five or six years the process of pruning is to be gradually commenced, in order that the branches may not too much interfere with each other. In about fourteen years from the date of planting, thinning out trees where they are too thick will now be proper; but as the upright growth of these trees renders their wood the more valuable, they should be left pretty close together, by which they will grow up tall. I have seen, says Miller, some of these trees growing whose naked stems have been more than seventy feet high, and as straight as a walking-cane; and from one of these trees there were as many boards sawed as laid the floor of a room nearly twenty feet square. If these trees, he adds, are left eight feet asunder each way, it will be sufficient room for their growth; therefore, if at first thinning a fourth part of the trees are taken away, the others may stand twelve or fourteen years longer, by which time they will be of a size for making ladders and standards for scaffolding, and many other useful purposes, so as to yield a remunerating sum for the original expense and rent of the land. In order to secure these advantages, it is necessary that the soil should be properly chosen; for there are instances in which, during thirty years, the average increase of the trees in height has hardly been an inch, while, in situations not particularly unfavourable, it might not be much less than thirty feet. It is fortunate, however, that those places which do not agree with the common pine are generally well adapted for the larch; so that if the planter finds his pines will not thrive, which he can soon do by observing the turpentine exuding through the leaves and buds, and covering them like hoar frost, he ought immediately to root them out, and replace them with larches. In like manner, when the larch exhibits this appearance on the leaves, and especially on the branches, it will never come to maturity. Care must be taken, however, not to mistake the *pollen* for this disease. The pollen appears only when the male flowers are in bloom; it has a tinge of yellow, and it seldom adheres to the leaves, and never to the branches; whereas, the turpentine is white and efflorescent, adheres to the twigs and leaves, and cannot be shaken off without difficulty.

An evidence of the advantages resulting from the cultivation of pines may be adduced from a portion of Culloden Muir, near to the spot where the battle was fought in 1746. It slopes to the north-east, and is exposed to the cold blasts of the Moray Firth. The subsoil is a deep bed of clay and sand gravel; and the surface, where not planted, very barren, with not more than an inch of mould, and that of the very worst quality. A portion was enclosed and planted, about seventy

years ago, by the celebrated Lord President Forbes. The successive thinnings had more than repaid the enclosing and planting; and when the timber was cut down, about twenty years since, it yielded several times as much rent per acre, for every year it had stood, as the unplanted part of the muir let at the time when it was cut down.

Large plantations of pines have been made in England during the last thirty years; and thus some of our barren lands, which were formerly utterly worthless, have become valuable additions to the national wealth. Sometimes these plantations have been formed without due investigation; and through this, some species of fir, which are useless except for fuel, have been raised in large quantities. On the other hand, the properties of the several species have been accurately studied by some planters; and experiments, upon a large scale, have been made to determine the relative value of the various sorts. At Dropmore, in Buckinghamshire, a place which, thirty years ago, was a most desolate and barren heath, Lord Grenville has formed the most valuable fir plantations; and he has established a garden of the genus *pinus*, in which he has collected almost every known species from all quarters of the globe. The late Bishop Heber, who was honoured with the friendship of that justly venerated nobleman, had a commission from him to search out any new species of the pines of India; and the following extract of a letter from this amiable prelate, addressed to his Lordship, giving an account of the pines of the Himalaya mountains, will show the solicitude with which he discharged his trust:—

"A visit which I paid to those glorious mountains, in November and December last, was unfortunately too much limited by the short time at my disposal, and by the advanced season, to admit of my penetrating far into their recesses; nor am I so fortunate as to be able to examine their productions with the eye of a botanist. But though the woods are very noble, and the general scenery possesses a degree of magnificence such as I had never before either seen or (I may say) imagined, the species of pine which I was able to distinguish were not numerous. The most common is a tall and stately, but brittle, fir, in its general character not unlike the Scottish, but with a more branching head, which, in some degree, resembles that of the Italian pine. Another, and of less frequent occurrence, is a splendid tree, with gigantic arms and dark narrow leaves, which is accounted sacred, and chiefly seen in the neighbourhood of ancient Hindoo temples, and which struck my unscientific eye as very nearly resembling the cedar of Lebanon. But these I found flourishing at near nine thousand feet above the level of the sea, and where the frost was as severe at night as is usually met with at the same season in England. But between this, which was the greatest height that I climbed, and the limit of perpetual snow, there is doubtless ample space for many other species of plants, to some of which a Dropmore winter must be a season of vernal mildness."

The pines of the Himalaya mountains were found at the height of nine thousand feet above the level of the sea. The elevation at which the pine grows in tropical countries is very remarkable. Humboldt describes the third zone of the Peak of Teneriffe, the region of firs, as at nine hundred toises of absolute height (about five thousand seven hundred and sixty feet); and he says that, in the Cordilleras of New Spain, under the torrid zone, the Mexican pines reach as high as two thousand toises (about twelve thousand eight hundred feet).

The other European species of the pine are: The *Corsican (p. laricio)*, which is nearly allied in its character to the Scotch pine, but is a much handsomer and finer tree. Professor Thouin considers it equally hardy with the Scotch pine; its wood is more weighty and resinous, and consequently more compact, stronger, and more flexible. It grows wild on the summits of the highest mountains of Corsica. The *cluster pine (p. pinaster)*, is a grand and picturesque tree; and is a great favourite with the Roman and Florentine painters. The timber is of less value than that of the others: in Switzerland, it is cut into shingles for roofing houses, &c. As an ornamental tree it is well deserving of culture, but not for its timber. The *stone pine (p. pinea)*, is very common in the south of Italy. At Ravenna there is an extensive forest of this species, and they are commonly planted around the villas, and in the gardens at Rome and Florence. The seeds of this and the cluster pine are eaten throughout Italy, both by the poor and rich. They are as sweet as almonds, but partake slightly of a turpentine flavour. The wood is not so resinous as that of most of the other species; and the tree can only be considered as valuable for its effect in the landscape. The *Siberian pine (p. cembra)*, the *tannenbaum* of Byron's Childe Harold, and the *aphernousli* pine of Harte, grows higher up the Alps than other pines; and is even found at elevations where the larch will not grow. The wood is very soft, and having scarcely any grain, is very fit for the carver. The peasants of the Tyrol, where this tree abounds, make various sorts of carved works with the wood, which they dispose of in Switzerland among the common people, who are fond of the resinous smell which it exhales. The *Canary pine (p. canariensis)*, grows in the high mountains of the Canary islands, at an elevation corresponding to the coldest parts of Scotland. The wood is resinous, highly inflammable, and is well adapted for building material, as it lasts for ages.

Of American species of the pine, Michaux

enumerates ten; a few of the most valuable of which we shall describe.

The *Red Pine (p. rubra)*, sometimes called the Norway pine, is found in Canada, Nova Scotia, and the northern parts of the States. It occupies small tracts of a few hundred acres, either alone, or singled with the white pine. It grows in dry and sandy soils to the height of seventy or eighty feet, and two feet in diameter. It is chiefly remarkable for the uniform size of its trunk for two-thirds of its length. The bark is of a clearer red than that of the other species. The cones are about two inches long, rounded at the base, and abruptly pointed. They shed their seeds the first year. The wood has a fine compact grain, and is very resinous; it is frequently employed in naval architecture, and affords masts for the largest ships. It is exported into Britain from the district of Maine, and the shores of lake Champlain.

The *Yellow Pine (p. mitis)*. This tree is widely diffused in North America. It is a beautiful and symmetrical tree, the branches forming a pyramid at the summit. It rises to the height of fifty and sixty feet, having a thickness of about eighteen inches: the leaves are rather short, of a bright green colour, and united in pairs. The cones are oval, armed with five spines, and of very small size. The concentric or annual circles of the wood, are six times as numerous in a given space, as those of the pitch and loblolly pines: the heart is fine grained, and moderately resinous, which renders the wood compact without great weight. Long experience has proved its excellence and durability; and it is universally employed in the countries where it grows as a domestic wood, as well as extensively imported to Britain and the West India islands.

170.

Cone of Long-leaved Pine.

The *Long-leaved Pine (p. australis)*, is also known as the yellow pitch, broom, and Georgia pine. It is first seen near Norfolk in Virginia, where the pine barrens begin; and it extends over the lower part of the Carolinas, and the states of Georgia and Florida, occupying dry sandy soils. Its mean stature is about sixty feet, with a uniform diameter of eighteen inches for two-thirds of its stem. The leaves are a foot long, of a beautiful brilliant green. The cones are also very large, being seven to eight inches long, and four inches thick when open. They are armed with retorted spines; the seeds are in general very abundant; the kernel is of an agreeable taste, and is voraciously eaten by wild turkeys, squirrels, and the swine that live almost wholly in the woods. In some unfruitful years, however, whole forests of hundreds of miles will not yield a single cone. The wood is compact, fine grained, durable, and susceptible of receiving a fine polish, advantages which give it a preference over every other species. These qualities, however, are much influenced and modified by the nature of the soil. It is extensively used in the States where it grows for all domestic purposes; and in naval architecture is reckoned superior to all the other pines. Sometimes the wood is of a reddish hue, when it is considered of superior quality. In England and the West Indies, it sells for thirty per cent. more than other pine woods. It is from this tree also that the principal supply of pitch, resin, and turpentine, is obtained; while the pine barrens being of vast extent, afford an abundant supply of these materials, both for home consumpt and exportation.

To obtain the turpentine, which begins to flow about the middle of March, and increases in the warm months of July and August, *boxes*, or hollows, are formed in the base of the pines, about three or four inches from the ground, generally on the south side. These boxes will contain about three pints of fluid; but they are made in proportion to the size of the trunk, of which they generally occupy about one-fourth of the diameter. On large trees, two, and sometimes four such boxes, are made on opposite sides. The ground is carefully raked and cleared of all brush wood around the trees, to prevent accidents from fire communicating with the boxes. On each side of this hollow two *notches* or gutters are made in the tree, to conduct the sap into the box or cavity; they are oblique, and about three inches long. During a fortnight, which is employed in this first operation, the boxes become filled, when the contents are taken out and conveyed into casks by wooden ladles. To increase the product, the upper edge of the box is newly chipped once a week, the bark, and a portion of the alburnum being renewed to the depth of four concentric circles. The boxes fill every three weeks; and the turpentine thus procured is of the purest quality. A tree continues thus to yield turpentine for five or six years; but the quantity is greatest in dry and warm years, and least in cold and wet. It is calculated that 250 boxes yield a barrel of 320 lbs. of turpentine. A single negro can attend to 4,000 boxes.

This substance contains resin, and the pure oil or spirit of turpentine, which latter is obtained by distillation in retorts.

All the tar of the southern States is made from dead wood of the long-leaved pine, which has fallen by accident, and from the summits of trees felled for timber. To obtain this tar, a circular mound of earth is raised with a ditch around the base; in the centre of this earthen mound is a hole communicating with the

ditch, the whole is coated with clay, and beaten hard; on this are piled the cut branches and pieces of wood divested of their bark. The wood is piled up so as to form a truncated and inverted cone; the whole is then strewed with pine leaves, and covered with earth, a few holes being left for air. Fire is communicated to the top, and a gradual and confined combustion is produced downwards to the base. As the tar flows into the ditch, it is emptied out into casks ready for receiving it.

The American tar is reckoned inferior to that of the north of Europe, probably from using dead wood, and less care being employed in its manufacture.

Dr Clarke thus describes the method of distilling tar in the gulph of Bothnia: "The process by which the tar is obtained is very simple: and as we often witnessed it, we shall now describe it, from a tar-work which we halted to inspect upon the spot. The situation most favourable for this process is in a forest near to a marsh or bog; because the roots of the fir, from which tar is principally extracted, are always the most productive in such places. A conical cavity is then made in the ground (generally in the side of a bank or sloping hill); and the roots of the fir, together with logs or billets of the same, being neatly trussed into a stack of the same conical shape, are let into this cavity. The whole is then covered with turf, to prevent the volatile parts from being dissipated, which, by means of a heavy wooden mallet, and a wooden stamper, worked separately by two men, is beaten down and rendered as firm as possible above the wood. The stack of billets is then kindled, and a slow combustion of the fir takes place, without flame, as in making charcoal. During this combustion, the tar exudes; and a cast-iron pan being at the bottom of the funnel, with a spout, which projects through the side of the bank, barrels are placed beneath this spout, to collect the fluid as it comes away. As fast as the barrels are filled, they are bunged and ready for immediate exportation. From this description, it will be evident that the mode of obtaining tar is by a kind of distillation *per descensum;* the turpentine, melted by fire, mixing with the sap and juices of the fir, while the wood itself, becoming charred, is converted into charcoal. The most curious part of the story is, that this simple method of extracting tar is precisely that which is described by Theophrastus and Dioscorides; and there is not the smallest difference between a tar-work in the forests of Westro-Bothnia, and those of ancient Greece. The Greeks make stacks of pine; and, having covered them with turf, they were suffered to burn in the same smothered manner; while the tar, melting, fell to the bottom of the stack, and ran out by a small channel cut for the purpose."

The *Pitch Pine (p. rigida)*, is common throughout the United States, but is most abundant on the Atlantic coast. It is a very branchy tree, and the wood is consequently knotty. It is very resinous, and affords a large quantity of pitch. The bark is thick, of a dark colour, and deeply furrowed. The concentric circles of the wood are far asunder; and three-fourths of the larger stocks consist of sap. On high ground and light gravelly soils, the wood is heavy and full of resin; on low humid soils it is the reverse, and unfit for use.

The *White Pine (p. strobus).* This is one of the most valuable and interesting species of pines, is common to Canada and the northern parts of the United States, and has its distinctive name from the perfect whiteness of its wood when freshly exposed. The leaves are five-fold, four inches in length, numerous, slender, and of a bluish green. The cones are four to five inches long, and composed of thin, smooth scales, rounded at the base. It grows extensively between the parallels of 43° and 47° in almost all varieties of soil; but attains its greatest dimensions in the upper part of New Hampshire, the State of Vermont, and near the source of the St Lawrence. This ancient and majestic inhabitant of the North American forests, is still the loftiest and most valuable of their productions; and its summit is seen at an immense distance aspiring towards heaven, far above the heads of the surrounding trees. The trunk is simple for two-thirds or three-fourths of its height; and the limbs are short and verticellate, or disposed in stages one above the other to the top of the tree, which is formed by three or four upright branches. This tree is the foremost in taking possession of barren districts, and the most hardy in resisting the impetuous gales from the ocean. On young stocks not exceeding forty feet in height, the bark of the trunk and branches is smooth and polished; as the tree advances in age it splits and becomes rugged, but does not fall off in scales like that of the other pines. The trunk also tapers and lessens from the base to the summit, more than those of the others of the same tribe. The wood is soft, light, free from knots, easily wrought, and very durable when exposed to the air and sun; on these accounts it is much employed in domestic use, a great proportion of the houses in the northern States being built of it.

171.

Cone of White Pine.

It is also largely exported to Britain, where it is much used in domestic architecture. The wood is not resinous enough to furnish turpen-

tine for commerce: nor would the labour of extracting it be easy, since it occupies exclusively tracts of only a few hundred acres, and is usually mixed in different proportions with the leafy trees.

The vast consumption of this tree for domestic use, says Michaux, who wrote about twenty years ago, and for exportation to the West Indies and to Europe, renders it necessary every year to penetrate farther into the country, and inroads are already made in quest of this species only upon forests which probably will not be cleared for cultivation in twenty-five or thirty years. The persons engaged in this branch of industry are in general emigrants from New Hampshire, led by a roving disposition, and a desire for amassing wealth. In summer, they unite in small companies, and traverse these vast solitudes in every direction to ascertain the places in which the pines abound. After cutting the grass and converting it into hay, for the nourishment of the cattle to be employed in their labour, they return home. In the beginning of winter they enter this forest again, establish themselves in huts covered with the bark of the canoe birch, or the arbor vitæ; and though the cold is so intense, that the mercury sometimes remains for several weeks from 40° to 45° below the point of congelation, they persevere with unabated courage in their work. When the trees are felled they cut them into logs from fourteen to eighteen feet long, and by means of their cattle, which they employ with great dexterity, drag them to the river; and after stamping on them a mark of property, roll them upon its frozen bosom. At the breaking up of the ice in the spring, they float down with the current.

About 120 miles from the sea the timber is collected, and each party forms his own into rafts, and either disposes of them to the proprietors of the various saw-mills on the banks of the river, or gets them formed into deals on his own account.

The upper part of Pennsylvania, near the source of the Delaware and Susquehannah, which is mountainous and cold, possesses large forests of this pine; and in the spring the timber is floated down those streams for the internal consumption of the state. It enters into the construction of houses, both in the country and in the towns, and is cut into planks for exportation to the West Indies.

Boston is the principal emporium for this wood in the northern States.

Besides deals for constructing the doors and other parts of the interior of their houses in America, the white pine is formed into what are called *clap boards* and *shingles*. These form the exterior coverings of the houses. These wooden houses last about twelve or fifteen years.

A great quantity of fir timber is annually imported into Great Britain from our Canadian possessions, and New Brunswick. Mr M'Gregor gives the following account of the mode of procuring this timber in the latter place:—

"The timber trade, which, in a commercial as well as political point of view, is of more importance in employing our ships and seamen, than it is generally considered to be, employs also a vast number of people in the British colonies, whose manner of living, owing to the nature of the business they follow, is entirely different from that of the other inhabitants of North America.

"Several of these people form what is termed a 'lumbering party,' composed of persons who are all either hired by a master lumberer, who pays them wages, and finds them in provisions, or of individuals who enter into an understanding with each other, to have a joint interest in the proceeds of their labour. The necessary supplies of provisions, clothing, &c., are generally obtained from the merchants on credit, in consideration of receiving the timber which the lumberers are to bring down the rivers the following summer. The stock deemed requisite for a *lumbering party* consists of axes, a cross-cut saw, cooking utensils, a cask of rum, tobacco, and pipes, a sufficient quantity of biscuit, pork, beef, and fish; peas and pearl barley for soup, with a cask of molasses to sweeten a decoction usually made of shrubs, or of the tops of the hemlock tree, and taken as *tea*. Two or three yokes of oxen, with sufficient hay to feed them, are also required to haul the timber out of the woods.

"When thus prepared, these people proceed up the rivers, with the provisions, to the place fixed on for their winter establishment; which is selected as near a stream of water, and in the midst of as much pine timber, as possible. They commence by clearing away a few of the surrounding trees, and building a camp of round logs, the walls of which are seldom more than four or five feet high; the roof is covered with birch bark or boards. A pit is dug under the camp to preserve any thing liable to injury from the frost. The fire is either in the middle or at one end; the smoke goes out through the roof; hay, straw, or fir branches are spread across or along the whole length of this habitation, on which they all lie down together at night to sleep, with their feet next the fire. When the fire gets low, he who first awakes, or feels cold, springs up, and throws on five or six billets; and in this way, they manage to have a large fire all night. One person is hired as cook, whose duty it is to have breakfast ready before daylight; at which time all the party rise, when each takes his *morning*, or the indispensable dram of raw rum immediately before breakfast. This meal consists of bread, or occasionally potatoes, with boiled beef, pork, or fish, and tea sweetened with

molasses; dinner is usually the same, with pease-soup in place of tea; and the supper resembles breakfast. These men are enormous eaters, and they also drink great quantities of rum, which they scarcely ever dilute. Immediately after breakfast, they divide into three *gangs:* one of which cuts down the trees, another hews them, and the third is employed with the oxen in hauling the timber, either to one general road leading to the banks of the nearest stream, or at once to the stream itself; fallen trees and other impediments in the way of the oxen are cut away with an axe.

"The whole winter is thus spent in unremitting labour: the snow covers the ground from two to three feet from the setting in of winter until April; and, in the middle of fir forests, often till the middle of May. When the snow begins to dissolve in April, the rivers swell, or, according to the lumberer's phrase, the *freshets come down.* At this time all the timber cut during winter is thrown into the water, and floated down until the river becomes sufficiently wide to make the whole into one or more rafts. The water at this period is exceedingly cold; yet for weeks the lumberers are in it from morning till night, and it is seldom less than a month and a half, from the time that floating the timber down the streams commences, until the rafts are delivered to the merchants. No course of life can undermine the constitution more than that of a lumberer and raftsman. The winter snow and frost, although severe, are nothing to endure in comparison to the extreme coldness of the snow water of the *freshets;* in which the lumberer is, day after day, wet up to the middle, and often immersed from head to foot. The very vitals are thus chilled and sapped; and the intense heat of the summer sun, a transition which almost immediately follows, must further weaken and reduce the whole frame. To stimulate the organs, in order to sustain the cold, these men swallow immoderate quantities of ardent spirits, and habits of drunkenness are the usual consequence. Their moral character, with few exceptions, is dishonest and worthless. I believe there are few people in the world on whose promises less faith can be placed than on those of a lumberer. In Canada, where they are longer in bringing down their rafts, and have more idle time, their character, if possible, is of a still more shuffling and rascally description. Premature old age, and shortness of days, form the inevitable fate of a lumberer. Should he even save a little money, which is very seldom the case, and be enabled for the last few years of life to exist without incessant labour, he becomes the victim of rheumatisms and all the miseries of a broken constitution. But, notwithstanding all the toils of such a pursuit, those who once adopt the life of a lumberer seem fond of it. They are in a great measure as independent, in their own way, as the Indians. In New Brunswick, and particularly in Canada, the epithet 'lumberer' is considered synonymous with a character of spendthrift, and villanous and vagabond principles. After selling and delivering up their rafts, they pass some weeks in idle indulgence: drinking, smoking, and dashing off, in a long coat, flashy waistcoat, and trowers, Wellington or Hessian boots, a handkerchief of many colours round the neck, a watch with a long tinsel chain and numberless brass seals, *and an umbrella.* Before winter they return again to the woods, and resume the pursuits of the preceding year. Some exceptions, however, I have known to this generally true character of lumberers. Many young men of steady habits, who went from Prince Edward's island, and other places, to Miramichi, for the express purpose of making money, have joined the lumbering parties for two or three years, and, after saving their earnings, returned and purchased lands, on which they now live very comfortably."

The "lumberers" of New Brunswick, and those who cut down the timber of the woods of the United States, select the firs of proper girth and quality with especial care. It is stated by Mr M'Gregor, that not one tree in ten thousand is fit for purposes of commerce. These thinnings, therefore, of the woods of North America do not produce the destruction of timber which now forms a subject of complaint in that country of forest trees. The indiscriminate clearings of the agricultural settlers, and the conflagrations which occasionally take place, are the causes which, in a few centuries, may render North America no longer an exporting country for timber. Sometimes the forests are injudiciously set on fire by the settlers, to save the labour of cutting and partially burning; but by such indiscriminate conflagration, the land is not properly cleared, and a very strong and noxious plant, called the fire-weed, instantly springs up, exhausting all the fertility of the ground. Sometimes these conflagrations extend over the whole face of a country, producing the most fearful destruction of life and property. The spectacle of a burning forest, according to the accounts of those who have witnessed it, is most sublime. The flames leap from tree to tree, and rushing up to their tops, throw out immense volumes of fire from the thick clouds of smoke that hang over the burning mass, while the falling trees come down with the most tremendous crash. One of the most destructive of these fires took place a few years ago in New Brunswick. We extract an account of this calamity from Mr M'Gregor's work:—

"In October 1825, upwards of a hundred miles of the country, on the north side of Miramichi river, became a scene of the most dreadful con-

flagration that has perhaps ever occurred in the history of the world. In Europe we can scarcely form a conception of the fury and rapidity with which the fires rage through the American forests during a dry hot season; at which time the underwood, decayed vegetable substances, fallen branches, bark, and withered trees, are as inflammable as a total absence of moisture can render them. When these tremendous fires are once in motion, or at least when the flames extend over a few miles of the forest, the surrounding air becomes highly rarefied, and the wind naturally increases to a hurricane. It appears that the woods had been, on both sides of the north-west branch, partially on fire for some time, but not to an alarming extent, until the 7th of October, when it came on to blow furiously from the north-west, and the inhabitants on the banks of the river were suddenly alarmed by a tremendous roaring in the woods, resembling the incessant rolling of thunder; while, at the same time, the atmosphere became thickly darkened with smoke. They had scarcely time to ascertain the cause of this phenomenon, before all the surrounding woods appeared in one vast blaze, the flames ascending more than a hundred feet above the tops of the loftiest trees, and the fire, like a gulph in flames, rolling forward with inconceivable celerity. In less than an hour, Douglastown and Newcastle were enveloped in one vast blaze, and many of the wretched inhabitants, unable to escape, perished in the midst of this terrible fire."

A Miramichi paper, published on the 11th of October, at the scene of this fearful conflagration, contains some interesting particulars, from which it appears that several hundred lives were lost in Newcastle, Douglastown, and Fredericton; that nearly all the "lumberers" in the woods perished; that in many parts of the country the cattle were all destroyed; and that the loss of property in the towns was immense, as the fire rushed upon the inhabitants with such inconceivable rapidity, that the preservation of their lives could be their only care.

The Firs, or Spruces *(abies)*, form another genus of the *coniferæ*, differing from the pines in the form and position of the leaves, as well as in the general aspect of the trees. In the firs the leaves are generally shorter than in the pines, and placed solitary instead of in pairs.

The Norway Spruce Fir (abies communis) is a beautiful and stately tree. The branches are verticillate, and spring from a common centre. The leaves are solitary, short, slightly arched, and acute, of a dark green colour, which gives to the tree a sombre aspect. The cones are cylindrical, five to six inches in length, and contain small winged seeds, which ripen in November. This is one of the tallest of our European firs, with a very straight but not thick trunk. It is a native of the north of Germany and Russia, and particularly abundant in Norway, from whence it is largely imported into this country, both as spars and as the white deal of that country and the Baltic. The timber is inferior to that of the common pine in durability, and being often knotty, is not proportionally strong for horizontal beamings. It is used, however, for a great variety of purposes in building; and the entire trees are more prized than any others for masts for small craft, or spars. What constitutes the value of this fir is, that, like the larch, its timber is equally durable at any age; and its perfectly erect and straight form well suits it for "the mast of some great admiral!" The tree may be cut for rods, stakes, and scythes, or the handles of other implements, where the trunk at the base is not more than ten inches in diameter, and the bark being retained, it will prove almost as durable as the larch. This tree is peculiarly valuable as a nurse, from being evergreen, and closely covered with branches, by which radiated heat is retained. It will not, however, grow in elevated situations, where the pine and larch flourish. By incision it yields resin and Burgundy pitch. The tops, or young sprouts, give the flavour to what is called spruce beer.

The *white*, *black*, and *red spruces* are natives of America, and nearly resemble, in their general properties, those of Europe. The black spruce is reckoned the most durable. In America it is used for knees for ship-building, where neither oak nor larch can be easily obtained. These knees are not prepared from two diverging branches, as in the oak; but from a portion of the base of the trunk connected with one of the largest diverging roots. The timber of the red spruce is universally preferred throughout the United States for sail yards; and imported into this country from Nova Scotia, for this purpose also. It is chiefly from the decoction in water of young shoots of the black spruce, and not exclusively from those of the white species, that spruce beer is prepared by fermentation with sugar or molasses. The essence of spruce of the dealers, is prepared by evaporating the decoction to the consistence of honey.

The *Silver Fir (a. picea)*, is one of the most beautiful of this family. When standing alone and developing itself naturally, its branches, which are numerous and thickly garnished with leaves, diminish in length as they approach the top, and thus form a pyramid of perfect regularity. The upper surface of the leaves is of a beautiful vivid green; and their under surface has two white lines running lengthwise on each side of the midrib, giving the leaves that silvery look from whence the common name is derived. The cones are nearly cylindrical, about eight inches long, and always directed upwards. The wood is light and slightly resinous, and inferior to that of the common pine. The resin of this

tree is sold in England and in America under the name of balsam, or *balm* of *Gilead*, although

172.

The Silver Fir.

the true balm of Gilead is produced from a totally different tree, the *amyris Gileadensis*.

Two new species of coniferæ, of more gigantic dimensions than any that have hitherto been described in Europe or America, have been found by Mr David Douglas, a most enterprizing botanist, who was sent out by the Horticultural Society of London in 1825, to explore the west coast of North America. He returned from that country in the autumn of 1827, bringing with him a rich addition to the known catalogue of plants. These pines are:—

1. *Pinus Douglasii.* This pine grows to the height of two hundred and thirty feet, and is upwards of fifty feet in circumference at the base. It has a rough corky bark, from an inch to twelve inches thick. The leaves resemble those of the spruce, and the cones are small. The timber is of good quality, and very heavy. This pine was found by Mr Douglas on the banks of the Columbia, where it forms extensive forests, extending from the shores of the Pacific to the Stoney Mountains.

2. *Pinus Lambertiana.** This species of pine was discovered in Northern California, where it is dispersed over large tracts of country, but does not form dense forests like most of the other pines. It is a very majestic tree; and one specimen which, in consequence of its having been blown down, Mr Douglas was enabled to measure, was two hundred and fifteen feet in length, fifty-seven feet nine inches in circumference at three feet from the root, and seventeen feet five inches at one hundred and thirty-four feet. It is probably the largest single mass of timber that ever was measured by man, though some of the growing specimens of the same pine were evidently of greater elevation. The trunk of the *Lambertiana* is straight, and clear of branches for about two-thirds of the height. The bark is uncommonly smooth, and the whole tree has a most graceful appearance. The cones resemble those of the Weymouth pine, but are much larger, being on an average at least sixteen inches in length. The seeds are eaten roasted, or pounded into cakes. The tree bears a considerable resemblance to the spruces; and as is the case with them, its turpentine is of a pure amber colour, and the timber soft, white, and light. One singular property of this tree is, that when the timber is partly burned the turpentine loses its peculiar flavour, and acquires a sweetish taste. It is used by the natives as a substitute for sugar.

* The name of this pine was given to it as a tribute to Lambert, the author of a most splendid work on the genus *Pinus*.

The Larch *(larix communis)* is, after the common pine, probably the most valuable of the tribe. The name seems derived from the Celtic *lar*, fat, in allusion to the resinous juice which it exudes. Dioscorides remarks that *larix* is the Gallic name for resin. Though a native of the mountains of more southern regions, it thrives uncommonly well in Britain; and as it grows more rapidly, and also in more varied soils than the other, it is, perhaps, better adapted for general cultivation. In the south it attains an immense height; some single beams of larch, employed in the palaces and public buildings of Venice, being said to be one hundred and twenty feet long. Even in the plantations of the Duke of Athol, and other proprietors in Perthshire, some larches are at least one hundred feet high. The wild alternation of hill and valley in that county, with the general opening of the glens and exposure of the surface to the south, seem to afford the larch a situation something like its native locality in the Tyrolese and Dalmatian Alps; for though other trees, and some of them fast growing ones, such as the spruce, have been planted at the same time, the larch overtops them all; and in summer, when it is in the full luxuriance of its leaves (which are a bright clover green), it rises over the dark forest like an obelisk of beryl. The larch sheds its leaves, and is probably by that means saved from those keen blasts of the very early spring that prove destructive to pines. Even when naked it is an ornamental tree. The trunk is generally straight, tapering gradually to a point; the branches, which are rather small in proportion to the tree, taper up in the form of a perfect cone; and the whole is of a lively brown, streaked with a golden colour.

A few larches are said to have been introduced into this country in the early part of the seventeenth century, as rarities; but it only began to be cultivated as a forest tree about the middle of the eighteenth century. Since that time it has been extensively planted, more especially in Scotland;

and the success has been far greater, and far more uniform, than in the case of any other tree not a native of the country. It appears that the quality of larch timber does not depend so much upon the maturity of the tree, and the slowness of its growth, as that of the pine,—as a fishing boat built of larch, only forty years old, has been found to last three times as long as one of the best Norway pine. It is not so buoyant, however, nor so elastic; and as it does not dry so completely as pine, boards of it are more apt to warp. It is, however, much more tough and compact; and what are very valuable properties, it approaches nearly to being proof, not only against water, but against fire. If the external timbers, and the principal beams of houses, were made of larch, fires would not only be less frequent, but they would be far less destructive; for before a larch beam be even completely charred on the surface, a beam of pine, or of dry oak, will be in a blaze beyond the ordinary means of extinguishment. Larch, however, is heavier to transport and elevate, and also much harder to work, than pine; and as these circumstances are all against the profits of the builder, they probably prevent the introduction of this most safe and durable timber. The Venetian houses constructed of it show no symptoms of decay; and the complete preservation of some of the finest paintings of the great masters of Italy is, in some respects, owing to the panels of larch on which they are executed.

The objects for which larch timber seems preferable to every other, are chiefly these:—gates, palings, posts of all kinds that are inserted either in the earth or in water, wooden buildings, many agricultural implements, cottage furniture, bridges and gangways, carriages for transporting stones and all hard and rough materials, barrows for builders and road makers, lighters, fenders, and embanking piles, lock and dock gates for canals and harbours, coal and lime waggons, vessels for carrying lime, pit-props, and hop poles of the smaller thinnings. For all these purposes, and many minor ones, larch would come considerably cheaper than any timber now in use; and would, in the average of them, last at least thrice as long,—the saving to the public would thus be immense; and the lands upon which an abundant supply might be raised in every county, are at present lying idle.

There is a variety of the larch with red, and another with white flowers; one with grayish bark, called the Russian larch, and one with pendulous branches. The black and red are considered either distinct species, or sub-species. The timber of both is said to be harder than that of the common white larch; but these trees have never yet had a fair trial in this country. The red larch trees in the Athol estates do not contain one-third as many cubic feet of timber as the white larch of the same age. The wood is so heavy that it will scarcely swim in water. Such is the rapidity of growth of the white larch, that on the estates of the Duke of Athol, at an elevation of 1600 feet, in the course of eighty years, a tree has arrived at the size to produce 300 cubic feet of timber of such durability, as to be fit for any use. According to Sang, the superiority of the larch over the Scotch pine is, that it brings double the price at least per measurable foot; that it will arrive at a useful timber size in one-half, or a third of the time which the pine in general requires; and, above all, that the wood of the larch, at forty or fifty years old, if in a suitable soil and climate, is in every respect superior to that of the pine at one hundred years old. The chief objections to the timber of the larch are its liability to warp and twist; but this is said to be obviated by barking the trees in spring while growing, and not cutting them down till the following autumn, or even for a year afterwards; this is also said to prevent the timber from being attacked by dry-rot.

The bark of the larch is more than half as valuable as that of the oak in tannin, and the tree yields turpentine by incision. The best timber is that which has grown on elevated, cold, and bare soils.

The Black Larch of America (l. pendula), called by the Indians *tamaracke*, or *hackmatack*, is a beautiful tree, resembling the European species, both in appearance and in the excellent quality of the wood and bark.

The Cedar of Lebanon *(l. cedrus)*. This celebrated tree is a native of the coldest parts of the mountains of Libanus, Amanus, and Taurus; but it is not now to be found in those situations in great numbers. Maundrell, in his journey from Aleppo to Jerusalem, in 1696, could reckon only sixteen large trees, although there were many small ones. One of the largest was twelve yards in the spread of its boughs. The forest of Lebanon never seems to have recovered the havoc made by Solomon's forty score thousand hewers, so that we have now probably more cedars in England than there are in Palestine.

173.

The Cedar.

This tree would, if the rapidity of its growth were at all correspondent with its other qualities, be the most valuable in the forest. Its resistance to absolute wear is not indeed equal to that of the oak; but it is so bitter, that no insect whatever will touch it, and it seems to be proof against Time himself. We are told that the timber in the temple of Apollo at Utica was found undecayed after the lapse of two thousand years; and that a beam in the oratory of Diana, at Saguntum in Spain, was carried from Zante, two

centuries before the Trojan war. Some of the most celebrated erections of antiquity were constructed of this tree. "Solomon raised a levy of thirty thousand men out of all Israel; and he sent them to Lebanon, ten thousand a month, by courses; and he had threescore and ten thousand that bore burthens, and fourscore thousand hewers in the mountains. And he covered the temple with beams and boards of cedar. And he built chambers against it, which rested on the house, with timber of cedar. And the cedar of the house within was carved with knops and flowers: all was cedar, there was no stone seen." Thus writes the sacred historian, who mentions that the same monarch had a palace of cedar in the forest of Lebanon. Ancient writers notice that the ships of Sesostris, the Egyptian conqueror, one of them two hundred and eighty cubits long, were formed of this timber; as was also the gigantic statue of Diana in the temple at Ephesus. Some difficulty, no doubt, exists, with regard to the ancient history of this celebrated tree,—there being other trees, still named cedars, which, though somewhat resembling them, do not belong to the same genus, as the white cedar, which is a cypress; and the red, which is a juniper.

In addition to the durability of its timber, the cedar is, in its appearance, the most majestic of trees; and when it stands alone in a situation worthy of it, it is hardly possible to conceive a finer vegetable ornament. Its height in this country has seldom equalled the taller of the larches, though it has nearly approached to it; but the very air of the tree impresses one with the idea of its comparative immortality. There is a firmness in the bark and a stability in the trunk, in the mode in which that lays hold of the ground, and in the form of the branches and their insertion into the trunk, not found in any other pine, scarcely in any other tree. The foliage, too, is superior to that of any other of the tribe, each branch being perfect in its form: the points of the leaves spread upwards into beautiful little tufts; and the whole upper surface of the branch, which droops in a graceful curve toward the extremity, having the semblance of velvet. The colour is also fine; it is a rich green, wanting the bluish tint of the pine and fir, and the lurid and gloomy one of the cypress.

The description of the cedar of Lebanon by the prophet Ezekiel, is fine and true:—"Behold the Assyrian was a cedar in Lebanon, with fair branches, and of an high stature; and his top was among the thick boughs. His boughs were multiplied, and his branches became long. The fir trees were not like his boughs, nor the chestnut trees like his branches; nor any tree in the garden of God like unto him in beauty."

Whether the cedars of Lebanon were thinned to exhaustion by the fourscore thousand axes of the king of Israel, or whether they have decayed in consequence of some variation of climate, or other physical change in the country, it is impossible to say; but modern travellers represent that very few now exist, though some are of immense bulk—about thirty-six feet in circumference, and quite undecayed.

The cedar of Lebanon, though it has been introduced into many parts of England as an ornamental tree, and has thriven well, has not yet been planted in great numbers for the sake of its timber. No doubt it is more difficult to rear, and requires a far richer soil than the pine and the larch; but the principal objection to it has been the supposed great slowness of its growth, although that does not appear to be very much greater than in the oak. Some cedars, which have been planted in a soil well adapted to them, at Lord Carnarvon's, at Highclere, have grown with extraordinary rapidity. Of the cedars planted in the Royal garden at Chelsea, in 1683, two had, in eighty-three years, acquired a circumference of more than twelve feet, at two feet from the ground, while their branches extended over a circular space forty feet in diameter. Seven and twenty years afterwards the trunk of the largest one had increased more than half a foot in circumference; which is probably more than most oaks of a similar age would do during an equal period. The surface soil in which the Chelsea cedars throve so well, is not by any means rich; but they seem to have been greatly nourished from a neighbouring pond, upon the filling up of which they wasted away.

Various specimens of the cedar of Lebanon are mentioned as having attained a very great size in England. One planted by Dr Uvedale, in the garden of the manor-house at Enfield, about the middle of the seventeenth century, had a girth of fourteen feet in 1789; eight feet of the top of it had been blown down by the great hurricane in 1703, but still it was forty feet in height. At Whitton, in Middlesex, a remarkable cedar was blown down in 1779. It had attained the height of seventy feet; the branches covered an area one hundred feet in diameter; the trunk was sixteen feet in circumference at seven feet from the ground, and twenty-one feet at the insertion of the great branches twelve feet above the surface. There were about ten principal branches or limbs, and their average circumference was twelve feet. About the age and planter of this immense tree its historians are not agreed, some of them referring its origin to the days of Elizabeth, and even alleging that it was planted by her own hand. Another cedar, at Hillingdon, near Uxbridge, had, at the presumed age of 116 years, arrived at the following dimensions: its height was fifty-three feet, and the spread of the branches ninety-six feet from east to west, and eighty-nine from north to south. The circum-

ference of the trunk, close to the ground, was thirteen feet and a half; at seven feet it was twelve and a half; and at thirteen feet, just under the branches, it was fifteen feet eight inches. There were two principal branches, the one twelve feet and the other ten feet in girth. The first, after a length of eighteen inches, divided into two arms, one eight feet and a half, and the other seven feet ten. The other branch, soon after its insertion, was parted into two, of five feet and a half each.

THE YEW TREE, *taxus baccata; diœcia, monadelphia*, of Linnæus, (called *taxus*, probably

174.

The Yew.

from the Greek, which signifies swiftness, and may allude to the velocity of an arrow shot from a yew tree bow,) is a tree of no little celebrity, both in the military and the superstitious history of England. The common yew is a native of Europe, of North America, and of the Japanese isles. It used to be very plentiful in England and Ireland, and probably also in Scotland. Cæsar mentions it as having been abundant in Gaul; and much of it is found in Ireland, imbedded in the earth. The trunk and branches grow very straight; the bark is cast annually; the wood is red and veined; it is compact, hard, and very elastic. It is, therefore, of great use in every branch of the arts in which firm and durable timber is required; and, before the general use of fire-arms, it was in high request for bows: so much of it was required for the latter purpose, that ships trading to Venice were obliged to bring ten bow staves along with every butt of Malmsey.

The yew was also consecrated—a large tree, or more, being in every churchyard; and they were held sacred. Flood gates for ponds made of it, are said to be of incredible duration. The twigs and leaves of this tree eaten, even in very small quantities, are certain death to horses and cows; but deer, it is said, will crop them with impunity; and sheep and goats, according to Linnæus, eat them readily. Turkeys, peacocks, and other poultry birds, eat both the leaves and fruit with impunity. The leaves, if eaten by man, are fatal; and the berries, if taken in any quantity, are deleterious. In funeral processions the branches were carried over the dead by mourners, and thrown under the coffin in the grave. According to Ray, the yew being an evergreen, was thus made typical of the immortality of man. The following extract from the ancient laws of Wales will show the value that was there set upon these trees, and also how the consecrated yew of the priests had risen in value over the reputed sacred misletoe of the Druids:—

"A consecrated yew, its value is a pound.
"A misletoe branch, threescore pence.
"An oak, sixscore pence.
"Principal branch of an oak, thirty pence.
"A yew tree, (not consecrated) fifteen pence.
"A sweet apple, threescore pence.
"A sour apple, thirty pence.
"A thorn tree, seven pence half penny. Every tree after that, fourpence."

By a statute made in the fifth year of Edward IV., every Englishman, and Irishman dwelling with Englishmen, was directed to have a bow of his own height made of *yew*, *wych-hazel*, *ash*, or *awburne*—that is, laburnum, which is still styled "awburne saugh," or awburne willow, in many parts of Scotland. His skill in the use of the long bow was the proud distinction of the English yeoman, and it was his boast that none but an Englishman could bend that powerful weapon. It seems that there was a peculiar art in the English use of this bow; for our archers did not employ all their muscular strength in drawing the string with the right hand, but thrust the whole weight of the body into the horns of the bow with the left. Chaucer describes his archer as carrying "a mighty bowe;" and the "cloth-yard shaft," which was discharged from this engine, is often mentioned by our old poets and chroniclers. The command of Richard III. at the battle which was fatal to him, was this:

"Draw archers, draw your arrows to the head."

The bowmen were the chief reliance of the English leaders in those bloody battles which attended our unjust contests for the succession to the crown of France. Some of these scenes are graphically described by Froissart.

In the account of the battle of Blanchetagne (the passage of the Somme), just before Crecy, Froissart says: "The Frenchmen defended so well the passage at the issuing out of the water, that they (the English) had much to do. The Genoese did them great trouble with their cross-bows. On the other side, the archers of England shot so wholly together, that the Frenchmen were fain to give place to the Englishmen."

At Crecy—"There were of the Genoese cross-bows about a fifteen thousand, but they were so weary of going a-foot that day, a six leagues, armed with their cross-bows, that they said to their constables, 'We be not well ordered to fight this day, for we be not in the case to do any great deeds of arms; we have more need of rest.' The words came to the Count d'Alençon, who said, 'A man is well at ease to be charged with

such a sort of rascals, to be faint and fail now at most need.'" A storm then ensues, which, and its passing away, are described in Froissart's own singular style. He then continues thus: "When the Genoese were assembled together, and began to approach, they made a great leap and cry to abash the Englishmen; but they stood still, and stirred not for all that. Then the Genoese again the second time made another leap and a fell cry, and stepped forward a little; and the Englishmen removed not one foot. Thirdly, again they leapt and cried, and went forth till they came within shot. They then shot fiercely with their cross-bows. Then the English archers stept forth one pace, and let fly their arrows so wholly, and so thick, that it seemed snow. When the Genoese felt the arrows piercing through heads, arms, and breasts, many of them cast down their cross-bows, and did cut their strings, and returned discomfitted. When the French king saw them fly away, he said, 'Slay these rascals, for they shall lett and trouble us without reason.' Then ye should have seen the men of arms dash in among them, and killed a great number of them; and ever still the Englishmen shot where as they saw thickest press. The sharp arrows ran into the men of arms, and into their horses; and many fell, horse and men, in the midst of the Genoese; and when they were down, they could not relieve again, the press was so thick that one overthrew another."

At Poitiers—"Then the battle began on all parts, and the battles of the marshals of France approached, and they set forth that were appointed to break the array of the archers. They entered a horseback into the way where the great hedges were on both sides, set full of archers. As soon as the men of arms entered, the archers began to shoot on both sides, and did slay and hurt horses and knights; so that the horses, when they felt the sharp arrows, they would in no wise go forward, but drew aback, and flang, and took on so fiercely, that many of them fell on their masters, so that for press they could not rise again, in so much that the marshals' battle could never come at the prince. . . . True to say, the archers did their company that day great advantage; for they shot so thick that the Frenchmen wist not on what side to take heed."

At the battle of Aljabarota, in Portugal, fought in the early part of Richard the Second's reign, between the kings of Portugal and Spain, the former aided by John of Gaunt, with an English force, and the latter by volunteers from France and Béarn, the English archers distinguished themselves greatly; indeed they chiefly contributed to win the battle, one of the bloodiest even of that time, by the total impossibility of bringing the horses to advance, or even stand fast under the arrows. Thus Froissart describes the encounter:—

"The same Saturday was a fair day, and the sun was turned towards even-song. Then the first battle (of the Spaniards) came before Aljabarota, where the king of Portugal and his men were ready to receive them. Of these French knights there were a two thousand spears, as fresh and well ordered men as could be devised; and as soon as they saw their enemies, they joined together like men of war, and approached in good order till they came within a bow-shot; and at their first coming there was a hard rencounter, for such as desired to assail, to win grace and praise, entered into the strait way, where the Englishmen by their policy had fortified them. And because the entry was so narrow, there was great press, and great mischief to the assailants; for such English archers as were there shot so wholly together that their arrows pierced men and horses, and when the horses were full of arrows they fell upon one another. . . . There were many of the lords and knights of France and Béarn taken and slain, and all their companies that were entered within the strait. Their horses were so hurt with the archers that they fell on their masters, and one upon another. There these Frenchmen were in great danger, for they could not help one another, for they had no room to enlarge themselves or to fight at their will."

It is to be observed, that long after the introduction of fire-arms in the fourteenth century, the bow continued to be a principal instrument of war. The bow was used at Agincourt and at Flodden.

The use of the bow as a weapon of war, or of the chase, has ceased in this country; but archery is still followed as an amusement; and though some of the foreign woods have more elasticity, the best bows of native growth are certainly those made of the yew tree.

The yew has often attained a very great size in each of the three kingdoms, though the specimens now remaining in Scotland and Ireland be but few. In the first of those countries, Queen Mary's yew at Crookstone was much celebrated, though probably more on account of the princess with whose history it was connected, than any peculiarity in its own magnitude. The trunk of a large yew, found by Pennant in the churchyard of Fortingal, in Perthshire, though wasted to the outside shell, and with only a few leaves at one point, is quoted by him as being fifty-six feet and a half in circumference, or about eighteen feet in diameter.

The yew tree at Mucruss abbey, in Ireland, has a trunk about six feet and a half in circumference, and fourteen feet high, which terminates in a head that fills the area of the cloisters.

In England and Wales some very large specimens are mentioned. According to Evelyn, the Crowhurst yew was thirty feet in circumference;

that at Braburne churchyard, in Kent, was nearly twenty feet diameter, although it had been dismantled by storms; and at Sutton, near Winchester, there was, as Evelyn quaintly says, "such another monster." At Hedsor, in Buckinghamshire, there was lately, if there be not still, one in health and vigour, full twenty-seven feet in diameter. In the woods of Cliefden, near Hedsor, there are some extraordinary remains of these trees, whose roots, apparently of vast age, twine about the chalk rocks in the most fantastic shapes.

Considering the immense size to which the yew grows, and the strength, durability, and even beauty of its timber, one cannot help regretting that, when those great trees shall have yielded, as yield they must, to the destructive power of time, there should not be a succession. It is true that, in consequence of the great improvement of the iron manufacture, and the cheapness of that article, it can be applied to many purposes for which the great strength of the yew was well adapted.

The custom of clipping yews into fantastic shapes was much practised in the sixteenth and seventeenth centuries. Some of our churchyards still have their yew trees thus cut into the pretended likenesses of birds and beasts. At Bedfont, in Middlesex, there are two celebrated trees, whose branches are annually shaped into something like the form of a peacock, with a date (1708) showing when this piece of useless labour was first performed. The Romans, as we learn from Pliny's letters, cut their evergreens into the fantastic shapes of birds and beasts. Lord Bacon, with his wonted good sense, protested against this practice, which was the fashion of his time. "I, for my part," he says in his Essays, "do not like images cut out in juniper and other garden stuff; they be for children."

THE CYPRESS *(cupressus sempervirens)*. The cypress obtains its name from the island of

175.

The Cypress.

Cyprus, where it grows in great abundance; the evergreen cypress is also a common tree in the Levant. It was planted by the Moors around their palaces, and both by the ancient and modern Romans as an ornamental tree around their villas. Of this species there are two varieties, the upright and the spreading, the last attaining a larger size than the other, and being thus more valuable as a timber tree. It thrives best in a warm, sandy, or gravelly soil; and though it has not been much cultivated in England as a timber tree, yet it seems well adapted for many situations in the southern parts of the kingdom. It is true that, in the early stages of its growth, it has been supposed to fall a victim to the keen frosts of our climate; yet Evelyn says that he had upwards of a thousand cypress trees in his garden, and did not lose more than three or four of them during the uncommonly severe winters of 1663 and 1665.

Of all timber, that of the cypress is generally supposed to be the most durable, superior even to that of the cedar itself. The doors of St Peter's church at Rome, which had been formed of this material in the time of Constantine, showed no sign of decay when, after the lapse of eleven hundred years, Pope Eugenius IV. took them down to replace them by gates of brass. In order to preserve the remains of their heroes, the Athenians buried them in coffins of cypress; and the chests or coffins in which the Egyptian mummies are found are usually of the same material. Cypress is a handsome timber. Though hard, it is elastic, and, therefore, would answer well for musical instruments. For furniture, it would be equal even to mahogany; for though not so beautiful in its colour, it is stronger, resists the worm equally, and its odour repels insects from whatever may be contained in a cabinet or chest made of it. For building, there is no timber superior to the cypress, which lasts almost as long as stone itself; accordingly, where it is found in great abundance, it is very much used for that purpose. The cypress is reputed to live to a great age; and though the precise period has not been ascertained, the fact of its being planted over the graves of the dead, and carried in funeral processions, as an emblem of immortality, is a proof that its duration must be very considerable.

The White Cedar is a native of America, where it grows to a considerable size, but it grows slowly, being eighty years old before it is fit for timber; and even then, though it answers well for hoops, small boats, roofing, and some other purposes, it does not appear very worthy of cultivation as a timber tree. But it is hardy, and forms a good variety in clumps of evergreens.

Arbor Vitæ (thuja occidentalis). The wood of this tree, which gives out when burnt an agreeable odour, was used by the ancients at their sacrifices; and hence the name from the Greek word *thuo*, to sacrifice.

The common arbor vitæ is a well known evergreen shrub in this country. In Canada, its

native locality, it however assumes the form and height of a tree, and the wood is considered more durable than any other. The trunk is sawn up into planks and boards for houses and boat building, and their branches are used for posts and fencing, the smaller branches and spray for besoms, and the leaves, made into an ointment, are used by the native Indians for the cure of rheumatism. In England the timber has been chiefly employed by the turner and cabinet maker.

In America the arbor vitæ succeeds best in soils where the roots have abundance of moisture, and it accordingly grows tallest in swamps and marshes; in dry situations it is stunted, and never grows to any degree of perfection. The first tree of this species which was sent to Europe was planted in the Botanic Garden at Fountainbleau, in the reign of Francis I. The Chinese species *(t. orientalis)* very nearly resembles the above; both are readily propagated by seeds, cuttings, and layers.

Norfolk Island Pine (araucaria excelsa). Diœcia, monadelphia, of Linnæus. This splendid

176.

Araucaria.

tree attains an immense size, often attaining not less than 220 feet in height. It is a native of Australia, and presents a magnificent object, with its bright evergreen foliage and innumerable waving branches. The leaves are closely imbricated, inflexed, and pointless. The longitudinal section of the wood, with all the distinctive marks of the coniferæ, exhibits the peculiarity of three rows of oval disks. From this circumstance, Mr Nicol of Edinburgh has identified the fossil tree of Craigleith quarry with the araucaria of Norfolk island.

Sir J. Bank's Araucaria (a. imbricata), is also a splendid and beautiful tree. It thrives well in the open air in this country, whereas the excelsa requires the protection of the green-house. The soil suited for this is an equal mixture of sandy loam and peat. Cuttings taken off at a joint will, with much care, take root if planted in a pot of sand, and placed under a bell-glass. We have as yet had little experience of the nature or durability of the wood. Spars for nautical purposes have been used, and apparently with advantage.

The Juniper (juniperus communis). Diœcia, monadelphia, of Linnæus. This plant is common in all the northern parts of Europe, in fertile or barren soils, on hills or in valleys, in open sandy plains, or in moist or in close woods. On the sides of hills its trunk grows long; but on the tops of rocky mountains and in bogs it is a tufted shrub. In England it is found chiefly in open downs, in a chalky or sandy soil. In Scotland it is found in granite, trap, and schistous hills and mountains; but not on the highest summits of the more elevated of the latter. In the south of Europe it is only found in elevated situations. It abounds in the Alps of Switzerland; but is not very common in the Appenines. In our shrubberies it forms a not ungraceful bush, grouping and combining very well with cypresses, American cedars, and various species of the pine and fir tribe. It is easily transplanted, and bears cropping. Grass will not grow beneath it; but the avena pratensis is said to destroy it. The wood is hard and durable; the bark is so tenacious, that it may be formed into ropes; and the berries are used for imparting the peculiar flavour to gin. Various insects feed on this shrub; and it is eaten by horses, sheep, and goats, when they can get nothing better. A gum oozes spontaneously from the trunk of old plants, which forms the gum sandarack, and in its powdered form is known as pounce. The berries require to remain two years on the tree before they assume the black form which indicates their maturity. The greater quantity of those which are used in Britain are brought from Germany, Holland, and Italy. They have a peculiar aromatic odour, and a sweetish, pungent, bitterish taste. In distillation with water they yield a volatile terebinthinate oil of a greenish colour, on which their virtues depend. The flavour and diuretic properties of Hollands arise from this oil. In medicine oil of juniper is used as a diuretic, and in this way has been employed for the cure of dropsy. The tops yield the same oil as the berries, and may be used instead of these.

Bermudas Cedar Wood is the product of a West Indian species of juniper. The *red cedar (j. Virginiana)* is one of the highest timber trees in Jamaica, affording large boards of a close fine texture, and reddish colour, very bitter to the taste, and avoided by all insects; hence it is employed by the cabinet makers for the manufacture of clothes' presses and drawers.

Common Savin (j. sabina). This plant, which only attains the size of a few feet in this country, is found as a tree in some of the Greek islands. The leaves and tops have a strong heavy disagreeable odour, and a bitter hot taste, with a considerable degree of acrimony. These qualities depend upon an essential oil, which is obtained in considerable quantity by distillation with water. Both water and alcohol extract its active principles. Savin is used in medicine as a powerful stimulant, both internally and externally, when applied to the skin.

Gum Olibanum, supposed to be the incense of the ancients, and the substance now used in the Catholic churches, is supposed to be the product of the *j. licia.*

Somewhat allied to the coniferæ is the family of plants *myrica,* or *candleberry myrtles.* One of these, the *sweet gale (myrica gale),* is common and very abundant in bogs and marshes in Scotland. It is a small shrub, with leaves somewhat like the myrtle or willow, of a fragrant odour and bitter taste, and yielding an essential oil by distillation. The northern natives formerly used this plant instead of hops; and it is still in use for that purpose in some of the western islands, and in some parts of the Highlands of Scotland. Unless it be boiled for a long time it is said to cause headache. The catkins, or cones, boiled in water, throw up a scum resembling bees wax, which, collected in sufficient quantities, would make candles. The plant is used to tan calf skins. Gathered in the autumn, it dyes wool a yellow colour, and is used for this purpose both in Sweden and Wales. The Swedes sometimes use a strong decoction to kill insects and vermin, and to cure the itch. An infusion of the leaves is also used as a vermifuge, and the dried leaves are generally employed to scent linen and other clothes. It is also made into brooms, and used as firewood to heat ovens. Horses and goats eat it, while sheep and cows refuse it.

Myrica Cerifera, or *Tallow Shrub,* is common in North America, where candles are made from the waxy substance collected from a decoction of the fruit or berry. It grows abundantly in a wet soil, and seems to thrive particularly well in the neighbourhood of the sea, nor does it seem ever to be found high up in the country. The berries intended for making candles are gathered late in autumn, and are thrown into a pot of boiling water, where the fatty or waxy substance floats on the top, and is skimmed off. When congealed, this substance is of a dirty green colour, somewhat intermediate in its nature between wax and tallow. After being again melted and refined, it assumes a transparent green hue. This substance, mixed with a proportion of tallow, forms candles, which burn better and slower than common tallow ones, and do not run so much in hot weather. They have, also, very little smoke, and emit a rather agreeable odour. A soap is also made of this substance, which has an agreeable scent, and is well adapted for a shaving soap, and is used by surgeons for plasters. In Carolina they likewise make a sealing wax from these berries. The root is used as a cure for toothache.

All the species grow well and readily in peat soil or sandy loam, in a moist situation. They are propagated by seeds or layers, but not readily by cuttings.

M. cerifera has been cultivated in France and in Germany, where it grows in the open air; and where, in many waste marshy situations, it might prove a profitable object of culture.

CHAP. XLV.

THE BANYAN TREE, BAOBAB.

We have in the foregoing chapters described the most useful trees, and in this shall consider some of the more remarkable and curious.

The Banyan Tree *(ficus Indica).** This singular tree belongs to the family of figs, natural order, *urticeæ.* It is a native of India; and it and another species *(f. religiosa),* are held in such veneration by the Hindoos, that if a person cuts or lops off any of the branches, he is looked upon with as great abhorrence as if he had broken the leg of one of their equally sacred cows.

This remarkable tree was known to the ancients, Strabo describes it, and states very accurately that after the branches have extended about twelve feet horizontally, they shoot down in the direction of the earth, and there root themselves; and when they have attained maturity, they propagate inward in the same manner, till the whole becomes like a tent supported by many columns. This tree is also noticed by Pliny with a minute accuracy, which has been confirmed by the observations of modern travellers; and Milton has rendered the description of the ancient naturalist almost literally, in the following beautiful passage:—

> "Branching so broad along, that in the ground
> The bending twigs take root; and daughters grow
> About the mother tree; a pillared shade,
> High over-arched, with echoing walks between.
> There oft the Indian herdsman, shunning heat,
> Shelters in cool; and tends his pasturing herds
> At loop-holes cut through thickest shade."

Another poet also describes it thus:—

> "'Twas a fair scene wherein they stood,
> A green and sunny glade amid the wood,
> And in the midst an aged Banian grew.

* For a figure of this tree, see Plate XI.

It was a goodly sight to see
That venerable tree,
For o'er the lawn, irregularly spread,
Fifty straight columns propt its lofty head;
And many a long depending shoot
Seeking to strike its root,
Straight, like a plummet, grew towards the ground.
Some on the lower boughs, which crost their way,
Fixing their bearded fibres, round and round,
With many a ring and wild contortion wound;
Some to the passing wind, at times, with sway
Of gentle motion swung;
Others of younger growth, unmov'd, were hung
Like stone-drops from the cavern's fretted height.
Beneath was smooth and fair to sight,
Nor weeds nor briers deform'd the natural floor;
And through the leafy cope which bower'd it o'er
Came gleams of chequer'd light.
So like a temple did it seem, that there
A pious heart's first impulse would be prayer." *

Some specimens of the Indian fig tree are mentioned as being of immense magnitude. One near Mangee, twenty miles to the westward of Patna, in Bengal, spread over a diameter of 370 feet. The entire circumference of the shadow at noon was 1116 feet, and it required 920 feet to surround the fifty or sixty stems by which the tree was supported. Another covered an area of 1700 square yards; and many of almost equal dimensions are found in different parts of India and Cochin China, where the tree grows in the greatest perfection. The fruit is small, not exceeding the size of a hazle nut, and is of no use.

The Mangrove *(rhizophora mangle)*. *Dodecandria, monogynia*, of Linnæus. This singular tree is a native of the East Indies and other tropical climates, where it grows in swampy situations on the coast, and penetrates even within low water mark of the sea. It attains the height of forty to fifty feet, and is an evergreen.

Dampier thus gives an accurate description of it. "The red mangrove groweth commonly by the sea side, or by rivers or creeks. It always grows out of many roots, about the bigness of a man's leg, some bigger, some less, which, at about six, eight, or ten feet above the ground, join into one trunk or body, that seems to be supported by so many artificial stakes. Where this sort of tree grows it is impossible to march, by reason of these stakes, which grow so mixed one among another, that I have, when forced to go through them, gone half a mile and never set my foot on the ground, stepping from root to root. The timber is hard, and good for many uses. The inside of the bark is red, and it is used for tanning of leather very much all over the West Indies."

What adds to the singularity of this tree is, that the seeds begin to germinate and send out roots while they are yet attached to the parent branches. This is the natural way in which the tree is propagated, by their roots descending and fixing themselves in the earth. The mangrove gave rise to the fable of oysters growing from trees, because, from its situation on the sea shores, and within tide mark, it becomes a favourite resort of those shell-fish, which cling to its branches, and thus have the appearance of growing from them.†

An extract has been prepared by boiling the bark in water, and then evaporating the solution till it becomes of the consistence of pitch. This extract is said to possess the tanning property in a very perfect degree; and by being prepared on the spot where the tree grows, a great saving of carriage and other expenses might be made.

The Umbrella Tree *(magnolia tripelata)*, a species of magnolia, a native of North America, has received this name from the form and position of its leaves. These leaves are from twelve to fifteen inches long, and five to six inches in breadth, narrowing to a point at each extremity, and placed at the ends of the branches in a circular manner, like an umbrella. The flowers, like all those of the magnolia family already described, are large, and of a beautiful white colour.

There is another tree, a native of India, which has also obtained the name of umbrella tree from the form of its branches, which spread out near the top into a close and very regular flat dome or circle. This tree affords the natives a shade from the sun, or a protection from the rain, and in this respect serves the purpose of an umbrella.

The Boabob, *adansonia digitata; monodelphia, polyandria*, of Linnæus, is a native of Western Africa, and is likewise said to be found in Egypt and Abyssinia; it is cultivated in many of the warmer parts of the world. There seems to be no doubt but that it is the largest known tree, its trunk being sometimes not less than thirty feet in diameter.

In Adanson's account of Senegal, some calculations are made regarding the growth of this tree, founded on the evidence of the annular layers. The height of its trunk by no means corresponds with the thickness which it attains. Thus, according to his calculations, at one year old its diameter is one inch, and its height five inches; at thirty years old it has attained a diameter of two feet, while its height is only twenty-two feet, and so on; till, at 1,000 years old, the boabob is fourteen feet broad, and fifty-eight feet high; and at 5,000 years the growth laterally has so outstripped its perpendicular height, that the trunk will be thirty feet in diameter, and only seventy-three feet high. The roots, again, are of a most extraordinary length; so that in a tree with a stem seventy-seven feet

* Southey's Curse of Kehama.

† See Plate VII., Fig. 9.

round, the main branch or tap root measures 110 feet in length.*

It often happens that the profusion of leaves and of drooping boughs almost hide the stem, and the whole forms a hemispherical mass of verdure, 140 to 150 feet in diameter, and sixty to seventy feet high. The wood is pale-coloured, light, and soft; so that in Abyssinia the wild bees perforate it and lodge their honey in the hollow, which honey is considered the best in the country. The negroes on the western coast, again, apply their trunks to a very extraordinary purpose. The tree is liable to be attacked by a fungus, which, vegetating in the woody part without changing the colour or appearance, destroys life, and renders the part so attacked as soft as the pith of trees in general. Such trunks are then hollowed into chambers; and within these are suspended the dead bodies of those to whom are refused the honour of burial. There they become mummies, perfectly dry, and well preserved, without further preparation or embalming, and are known by the name of giuriots. The boabob is emollient and mucilaginous: the pulverised leaves constitute *lalo*, a favourite article with the natives, which they mix with their daily food to diminish excessive perspiration; and which is even used by Europeans in fevers and diarrhœas. The flowers are large, white, and handsome; and in their first expansion bear some resemblance to the white poppy, having snow-white petals, and violet-coloured stamens. Both flowers and fruit are pendant, and the leaves drop off before the periodical rains come on. The fruit has already been described; it is of an oblong shape, of considerable size, and tastes like ginger-bread, with a pleasant acid flavour. The expressed juice, when mixed with sugar, forms a cooling drink, much used in putrid fevers: this juice also is generally used as a seasoning for corn-gruel and other food.

Dragon's Blood Tree, *(dracœna draco). Hexandria, monogynia*, of Linnæus. This tree is a native of the East Indies, but is found in the Canary islands, growing to an immense size. It has a singular appearance,† which can be better understood by a figure than by description. Humboldt describes one he saw in the Canary islands as forty-five feet in circumference. According to Sir George Staunton's measurement, one he saw was twelve feet in diameter at about ten feet from the ground. It is held in great veneration by the Guanchos, or inhabitants of these islands; is of extremely slow growth, and endures for ages. It and the boabob tree are perhaps the oldest vegetable inhabitants of the globe.

At certain times the trunk cracks in various parts, and emits a gum which concretes into tears, and is the red substance commonly known as *dragon's blood*. Other trees, however, yield a substance similar to this, although not reckoned so genuine. It being originally a native of the East Indies, the high veneration in which it is held by the Guanchos of the Canary islands, would indicate its introduction into those islands from the Indian continent; as also the original country of the primitive inhabitants of those islands.

Dragon's blood was at one time highly esteemed in medicine; but it is now little used. It possesses astringent properties in a very considerable degree.

Pandanus. There are several species of this family natives of the East and West Indies.

The *Green-spined Pandanus (p. odoratissimus)*, is a large spreading, branching bush, with imbricated leaves, which embrace the stem, bearing some resemblance to those of the pine apple. They are from three to five feet long, and are placed in three spiral rows round the extremities of the branches.

It grows in all soils and situations in the warm parts of Asia. It grows readily from branches, whence it is rare to find the full grown ripe fruit. The tender white leaves of the flowers, chiefly those of the male, yield that most delightful fragrance for which they are so generally esteemed, and for which the plant is cultivated in Japan. Of all perfumes it is by far the richest, and most powerful. The lower pulpy part of the drupe, is sometimes eaten by the natives in times of scarcity and famine. The tender white base of the leaves is also eaten, raw or boiled, at such times of scarcity. The taste of the pulpy part of the drupe is very disagreeable. The roots are composed of tough fibres, which basket makers use to tie their work with. They are so soft and spongy, as to serve the natives for corks. The leaves are composed of longitudinal tough fibres, which are used for various purposes. In the South sea islands, where the pandanus is also a native, this or some other species or variety, is employed for making mats. The leaves are beautifully white and glossy. In the Sandwich islands these mats are handsomely worked in a variety of patterns, and stained of different colours. The branches being of a soft, spongy, juicy nature, cattle will feed on them when cut into pieces. At Otaheite, they call this tree *wharra*.

Snakewood *(secropia peltata)*. This tree is a native of Jamaica, is singular in having the trunk and branches hollow everywhere, and sloped from space to space with membranaceous septas or divisions, and answering to so many annual marks on the surface. The leaves are large, peltate, lobed like those of the papaw tree, and placed at the ends of the branches. The

* See Plate XI. fig. 2. † See Plate VII. fig. 3.

fruit rises from the summit of a peduncle, and shoot into four, five, or more cylindrical berries, composed of a row of little acini, something like the common raspberry, which they resemble also in flavour, and are agreeable to most European palates on that account.

The wood, when dry, readily takes fire by attrition; and from this the native Indians have taken the hint, and kindle their fires in the woods by rubbing a piece of it against some harder wood. The bark is strong and fibrous, and is frequently used for all sorts of cordage. The trunk is very light, and for that reason much used for bark-logs and fishing floats. The smaller branches, when cleared of the divisions inside, serve for wind instruments. Both trunk and branches yield a great quantity of fine salt, which is much used among the French to refine and granulate their sugars. Pigeons and other birds feed readily on the fruit, and thus the tree is extensively propagated.

Poisonous Trees. The *upas tree (antiares toxicaria)*, has been fabled to diffuse a poisonous atmosphere around it, which is fatal to all animals that come within its influence. There is no truth in this assertion, although the inspissated juice of this tree, which belongs to the natural family *urticeæ*, is highly poisonous when taken into the stomach. Another, the *manchineal tree*, is also possessed of a highly acrid and poisonous juice. This tree grows to a vast size on the coasts of the Caribbean islands, and neighbouring continent. The leaves are ovate, serrated, acute, and shining. The fruit falls from the tree spontaneously, strewing the ground in immense numbers.

This fruit is highly poisonous. The whole tree abounds with a white milky juice, which is also of an acrid, poisonous quality. If a single drop of this juice falls on the skin, it causes a sensation like the touch of a hot iron, and raises a blister on the part. It is a common belief in that country, that to sleep under its branches will cause death. But Jaquin and his companions proved the fallacy of this, by sitting under it for three hours at a time with impunity. The wood is beautifully variegated with brown and white, and is highly prized for furniture and ornaments. The workmen who fell the trees first kindle a fire round the stem, by which means the juice becomes so much inspissated, as not to flow out when wounds are made with their axes. Whole woods on the sea coast of Martinique have been burnt in order to clear the country of such a dangerous plant.

The Tallow Tree *(croton sebiferum)*, is remarkable in yielding a substance very much resembling tallow in consistence, in colour, and even in smell. This tree grows abundantly in China, where the inhabitants convert its produce into candles.

Mr Clarke Abel describes it as being one of the largest, the most beautiful, and the most widely diffused, of the plants found by him in China. He first saw it a few miles south of Nankin, whence it occurred in greater or less abundance all the way to Canton. "We often saw it," he says, "imitating the oak in the height of its stem, and the spread of its branches. Its foliage has the green and lustre of the laurel. Its small flowers, of a yellow colour, are borne at the ends of its terminal branches. Clusters of dark-coloured seed-vessels succeed them in autumn; and, when matured, burst asunder and disclose seeds of a delicate whiteness."

The seed-vessels are hard brownish husks, not unlike those of chestnuts, and each of them contains three round delicately white kernels, resembling in size and shape our ordinary hazel-nuts, but having small stones in the interior. It is the hard white oleaginous substance surrounding these stones which possesses most of the properties of tallow; but on stripping it off it does not soil the hands. From the shell and stone, or the seed, oil is extracted, so that this fruit produces tallow for candles, and oil for lamps. To obtain its useful extract, the Chinese subject the fruit of the tallow-tree to much the same process as the seed of the *camellia oleifera*, or oil plant. It is ground in a trunk of a tree which is hollowed out, shaped like a canoe, lined with iron, and firmly fixed in the ground. Lengthways within this hollowed trunk there moves backwards and forwards a mill-stone, whose axis is fixed to a long pole laden with a heavy weight to increase the pressure, and suspended from a beam. The pendulum-like motion is given by a man or boy who grasps the pole, and with very little exertion sways it from side to side. After the seed has been thus pounded, it is thrown, with a small quantity of water, into a large iron vessel, exposed to fire, and reduced by heat into a thick consistent mass. It is then put hot into a case consisting of four or five broad iron hoops, piled one above the other, and lined with straw, and then pressed down with the feet as closely as possible till it fills the case. It is then carried to the press.

Another, and perhaps a more generally adopted process is, merely to boil the bruised seed in water, and to collect the tallowy matter that floats to the surface. A certain quantity of some vegetable oil, occasionally in as great a proportion as three pounds to every ten pounds procured from the tallow-tree, is mixed up with it.

It is not so consistent as tallow, and therefore to promote the better cohesion of the material, the candles made of it are dipped in wax; this external coating hardens them, and preserves them from guttering. The combustion of these candles is described as being less perfect, yielding a thicker smoke, a dimmer light, and con-

suming much more rapidly than ours. These serious defects are perhaps attributable in a great measure to the unappropriateness of the wick employed, which is merely a little rod of dry light wood (generally bamboo), with the pith of a rush wound round it; the pores of this pith serving as a medium to convey to the wood the inflammable matter with which it is surrounded.

Father D'Incarville mentions, in a letter written by him from Pekin, and published in the Philosophical Transactions for 1753, that almost all the candles sold in the southern provinces of China are made with tallow prepared from these berries. There are very few sheep in that part of the country; animal tallow is therefore very scarce, and this vegetable production is in consequence held in high estimation.

THE PINEY TREE (*vateria Indica*) growing on the coast of Malabar, yields a substance very much resembling that of the *croton sebiferum*. The peculiar product of this tree is fully described in an interesting paper on the subject, by Dr Benjamin Babington, who, from many experiments, has shown that its inflammable properties admirably adapt it for the manufacture of candles, it being in every way superior to animal tallow.

The useful matter is obtained by simply boiling the pulpy fruit of the piney tree in water, when the fused vegetable tallow rises to the surface, and, on cooling, forms a solid cake. No farther preparation is necessary. This substance is generally white, sometimes yellow, unctuous to the touch, "with some degree of waxiness, almost tasteless, and has an agreeable odour somewhat resembling common cerate." It takes a liquid form at the temperature of 97½° Fahrenheit, and consequently generally remains solid in India, in which respect it differs from palm or cocoa-nut oil. Its specific gravity at the melting point, or 97½°, is ·8965, and at 60°, is ·9260.

A piece of this tallow enveloped in folds of blotting paper was submitted to strong pressure, and scarcely sufficient *elain*, or pure oil, was expressed to imbue the inmost fold. Its tenacity and solidity are so great, that the united efforts of two strong men were in vain exerted to cut a round piece of nine pounds weight asunder with a fine iron wire, and it was no easy task to effect a division even with the assistance of a saw. Dr B. Babington likewise remarked that, "on a fracture being made, it exhibits a crystalline structure in small aggregated spheres, composed of radii emanating from a centre, not unlike the form of Wavellite." Animal tallow, when melted into large casks, and slowly cooled, has a somewhat similar appearance.

When piney tallow is manufactured into candles, they come from the mould freely, differing in this respect from wax, which it is found difficult to cast. These candles afford as strong a light as those made of animal tallow, and have the great advantage of being free from the unpleasant odour of the animal substance.

Piney tallow readily unites in all proportions with wax, spermaceti, and tallow, forming, when mixed with spermaceti and wax, a compound which fuses at a temperature approximating to their mean melting point, according to their relative proportions. A mixture with any of these ingredients has been found to form a better candle than when the pure and more fusible substance is alone employed. Dr B. Babington made several experiments to discover its inflammability compared with other substances; and ascertained with tolerable accuracy, that the piney tallow approaches nearer to animal fat in its rate of combustion than to spermaceti or wax, and that, all circumstances being similar, a less weight was consumed of this in a given time than of either of the other substances.

The natives have never hitherto applied this vegetable product as a means of affording light. Its concrete form is probably the cause of their having neglected it; as a solid substance is never used in India for feeding the flame of their wicks, and candles are unknown there. Their lamps are supplied with many fluid vegetable oils, which their country yields in profusion. The product of the piney tree is, however, employed medicinally by the Indians, who consider it as an excellent application for bruises and rheumatic pains.

A resin, very nearly similar in its properties to that of copal, exudes from the same tree, and furnishes a very durable natural varnish. This resin, when mixed up with the tallow of the piney tree, is used as a substitute for tar, in smearing the bottoms of boats.

The *vateria Indica* grows very commonly throughout the western coast of the peninsula of India, as far northward as the extreme limit of the province of Canara. A plentiful supply might therefore be readily obtained, which could be imported into this country at one-fourth the price of wax. Although it may not possess all the advantages of that substance, it is still considerably superior to animal tallow.

THE PITCHER PLANT, *nepenthes distillatoria; diœcia, monodelphia*, of Linnæus. This, though a herbaceous plant, may be included among the more singular productions of the vegetable kingdom. It is a native of China and the East Indies, and grows in marshy situations. The flower is a panicle. The leaves are sessile, oblong, and terminated at the extremities by a cylindrical, hollow vessel, exactly resembling a common water pitcher.

This pitcher is furnished with a lid, which opens and shuts by the contractions of a membranous hinge. In its native state this cup is

found filled with fluid secreted from the juices of the plant. What is remarkable, this fluid,

177.

Pitcher Plant.

is a pure and wholesome water, while the water of the soil in which the plant grows, is stagnant and unwholesome. From forty to fifty of these cups grow on a plant, each holding about an ounce or two of water.

This plant thrives, with care and attention, in hot-houses in this country, where the pitchers are fully developed. It requires a very damp atmosphere, and much heat.

CHAP. XLVI.

THE SPICE TREES AND PLANTS—CINNAMON, CAMPHOR, CLOVE, PEPPER, GINGER, &c.

The plants to be treated of in this chapter are distinguished by their aromatic qualities, depending on the existence of an essential oil, either diffused throughout the whole plant, or existing in the bark, fruit, or roots.

These aromatic species have been used as luxuries, and perhaps formed the first articles of commerce among the earliest races of mankind. In eastern countries, from the earliest times, they were employed as perfumes, and entered into the composition of most of their culinary dishes. The Egyptians, Greeks, and Romans used them in profusion both as articles of luxury, and at their religious ceremonies and funeral obsequies. Nor are they less esteemed by the moderns, or the inhabitants of the more temperate and colder regions of the globe. Into every country almost, are these fragrant and stimulating substances diffused by the universal agency of commerce.

The Cinnamon tree *(laurus cinnamomum)*. Natural family *laurineæ; enneandria, monogynia*, of Linnæus. This valuable and beautiful species of the laurel family, grows to the height of twenty to thirty feet. The trunk is short, erect, with wide spreading branches, and a smooth ash-coloured bark. The leaves stand in opposite pairs upon short footstalks; they are oval, three to five inches long, of a bright green above, and pale beneath, and traversed longitudinally by three whitish nerves. The flowers are in panicles, with six small petals; they have no show, and have a slight, rather fœtid odour. The fruit is the size of a middling olive, soft, insipid, and of a deep blue. It encloses a nut, the kernel of which germinates soon after it falls, and therefore cannot easily be transported to a distance. The timber is white, and not very solid; the root is thick and branching, and exudes abundance of camphor. The inner bark forms the cinnamon of commerce.

This tree is a native of Ceylon, to which place it was at one time thought that it was entirely confined; but it is now known to grow plentifully in Malabar, Cochin-China, Sumatra, and the eastern islands; and it has been cultivated in the

178.

Cinnamon Tree.

Brazils, the Mauritius, India, Jamaica, and other tropical localities. There are probably many varieties, and several species of this tree, modified by soil and climate. The soil in which it thrives best is nearly pure quartz sand. That of the cinnamon garden near Colombo, in Ceylon, was found by Dr Davy to consist of 98.5 of siliceous sand, and of only one part of vegetable matter in the hundred. The garden is nearly on a level with the lake of Colombo; its situation is sheltered; the climate is remarkably damp; showers are frequent; and the temperature is high, and uncommonly equable.

Although, ever since the Dutch first had a settlement in Ceylon, cinnamon was made by them a lucrative article of trade, and one which they strove by every means wholly to monopolize, this tree was not made by them an object of cultivation in the island until 1766. Before

that period cinnamon was collected in the forests and jungles, since an idea prevailed that its excellence depended on its spontaneous growth, and that if once subjected to culture, it would no longer be genuine.

When Falk was appointed governor of Ceylon, he felt the inconvenience of depending for a regular supply on such a resource, the more especially as the greater part of the cinnamon trees lay in the dominions of the king of Candy, who frequently, with or without apparent reason, refused the cinnamon peelers admission into his dominions, and the Dutch were, in consequence, often restricted to less than half their required annual exports.

Governor Falk, in his attempt to remedy this evil, by cultivating the cinnamon tree in the territory belonging to the Dutch, was discouraged by the prejudices of the natives, and discountenanced by the parsimony of the Supreme Government of Batavia. It was said, "for one hundred and fifty years Ceylon had supplied the requisite quantity of cinnamon, the expense of which was ascertained and limited: why then risk the success of a new plan, attended with extraordinary charges." This public spirited governor nevertheless persevered in his undertaking, and to his success the English owe the flourishing state in which they found the cinnamon plantations of Ceylon, when they captured that island. This tree is now cultivated in four or five very large gardens, the extent of which may in some measure be imagined by the quantity of cinnamon annually exported thence, amounting to more than 400,000 lbs.; and from the number of people who are employed in the cinnamon department, these being from twenty-five to twenty-six thousand persons.

The trade in this produce had always been a monopoly; during the government of the Dutch, this was enforced with an excessive degree of rigour, at which humanity revolts. It is painful to contemplate man, when greediness for exclusive gains, the meanest of all motives, incites him to acts of oppression and tyranny. "The selling or giving away the smallest quantity of cinnamon (even were it but a single stick), the exporting of it, the peeling of the bark, extracting the oil either from that or the leaves, or the camphor from the roots, except by the servants of government, and by their order, as well as the wilful injuring of a cinnamon plant, were all made crimes, punishable with death, both on the persons committing them, and upon every servant of government who should connive at it."

In order to keep up the price of the spices, the Dutch government was formerly accustomed to have these destroyed, when supposed to be accumulated in too large quantities. Sometimes, it was said, this oriental produce was thrown into the sea, and sometimes the work of destruction was accomplished by other means. M. Beaumare relates, that on the 10th June, 1760, he beheld, near the Admiralty at Amsterdam, a blazing pile of these aromatics, which were valued at eight millions of livres, and an equal quantity was to be burnt on the ensuing day. The air was perfumed with this incense, the essential oils, freed from their confinement, distilled over, mixing in one spicy stream, which flowed at the feet of the spectators; but no person was suffered to collect any of this, nor on pain of heavy punishment to rescue the smallest quantity of the spice from the wasting element!

The cinnamon tree is very difficult to rear in hot-houses in this country. Yet many plants are to be seen, which regularly flower and ripen their seeds in Britain.

Cassia, or *Bastard Cinnamon (l. cassia).* This tree is found in China, and several parts of South Asia. It yields the same products as the true cinnamon, but of inferior quality and value; and thus often serves to adulterate the other. What are called *cassia buds*, are the hexangular, fleshy receptacles of the seeds of the true cinnamon, and perhaps of the cassia trees.

The trees which are cultivated are kept as a sort of coppice, and numerous shoots spring apparently from the roots; these are not allowed to rise higher than ten feet. We are told, that when the trees first put forth their flame-coloured leaves and delicate blossoms, the scenery is exquisitely beautiful. In three years after planting, each tree affords one shoot fit for cutting, at the fifth year from three to five shoots may be taken; but it requires the vigour of eight years' growth before it yields as many as ten branches of an inch in thickness. From the ages of ten to twelve years is the period of its greatest perfection; but its duration of life is not limited, as the root spreads, and every year sends up new shoots or suckers.

Trees which grow in rocky situations, and the young shoots, when the leaves are of a reddish colour, yield the best and most pungent aromatic bark. The tree is known to be in the best state when the bark separates easily from the wood, and has the inside covered with a mucilaginous juice; but if that be not carefully removed, the flavour of the spice is injured. The shoots are cut when from half to three-quarters of an inch in thickness, and in lengths of from two to three feet. Many hands are employed in this work; each man is obliged to furnish a certain quantity of sticks. When this part of his task is fulfilled, he conveys his fragrant load to a shed allotted for the purpose, where the bark is instantly stripped from the wood, and freed from the ep - dermis, which is scraped off. The fragrance diffused around, during this process, is described as

being extremely delightful; but in parts of the plantation remote from this spot, unless the trees be agitated with violence, the peculiar smell of the cinnamon cannot be distinguished. The wood, deprived of the bark, has no smell, and is used as fuel.

When the bark is perfectly cleansed it is of a pale yellow colour, and about the thickness of parchment. It is then placed on mats, to dry in the sun, when it curls up, and acquires a darker tint. The smaller pieces are then put inside the larger, and the whole close together into the tubular form in which it is sold in the shops. When the rind, or part forming the cinnamon, is first taken from the tree, it is described as consisting of an outer portion which tastes like common bark, and an inner portion, which is very sweet and aromatic. In the course of the drying, the oil of the inner portion, on which the flavour depends, is communicated to the whole; and the quality of the entire bark is understood to depend more upon the relative quantities of those portions of the bark than upon anything else. The cinnamon of Ceylon has the outer portion much thinner, in proportion to the inner, than the cassia of other countries; and to that its higher pungency is attributed.

Under favourable circumstances, the cinnamon tree yields a large and a small harvest every year. The large one is obtained soon after the fruit is ripe; that is, when the tree has again pushed out shoots, and the sap is in vigorous circulation. May and June are the best months in the year for the great harvest; in November and December the little harvest is obtained. In those plantations which belong to government, however, there is but one harvest, beginning in May, and ending in October.

Though cinnamon has found a place in our Pharmacopeia, the purpose to which it has been applied by the South Americans, invests it with medicinal properties, which it is not usually supposed to possess. "One thousand bales (92,000 lbs.) are said to be consumed annually by the slaves in the mines of South America. Each receives daily a certain quantity, cut into pieces one inch in length, which he eats as a preservative against the noxious effluvia of the mines."

Oil of cinnamon was formerly obtained at Colombo, from distilling the fragments broken off in packing; latterly a great proportion has been made from coarse cinnamon unfit for exportation. A very small quantity of oil is contained in the bark; three hundred pounds of which are required to yield twenty-four ounces of oil, and consequently this is extravagantly dear. When made from the finest cinnamon its specific gravity is greater, but from the coarse sort it is less than that of water.

The Camphor Tree *(l. camphora)*. This tree grows to a considerable height, dividing into many branches covered with smooth greenish

179.

Camphor Tree.

bark. The leaves are ovate, lance-shaped, entire, smooth, nerved; on the upper side of a pale yellowish green colour, on the under glaucous. They stand upon long footstalks. The flowers are small, white, destitute of calyx, with a six-petalled corolla. The fruit resembles that of the cinnamon.

This tree is a native of Japan, growing abundantly in the woods of the western part of the island. It was first cultivated in Britain by Miller, and is a hardy hot-house plant. The roots, wood, and leaves have a strong odour of camphor. This substance is found to lodge every where in the interstices of the fibres of the wood, also in the pith, but most abundantly in the crevices and knots. To obtain the camphor, the parts of the tree are cut into chips, which are suspended in a net within a kind of still, or iron pot, the bottom of which is covered with water, and an earthen head fitted to it. Heat is then applied, and the steam of the boiling water penetrating the contents of the net, elevates the camphor into the capital, where it concretes on straws, with which this part of the apparatus is lined.

Many other plants yield camphor when treated in a similar manner. Pure camphor is white, pellucid, somewhat unctuous, of a bitterish aromatic acrid taste, accompanied afterwards by a sense of coolness, very volatile and inflammable, and when taken into the stomach, stimulating and narcotic.

It does not seem to have been known to the Greeks, but was much used by the Arabian physicians, and called *cafur* or *canfur*. Its odour is disagreeable, and destroys insects and vermin; and it is on this account used in museums. From its great volatility, however, it soon evaporates, unless confined in close boxes or bottles.

The Clove *(caryophyllus aromaticus.)* Natural family *myrtaceæ; icosandric, monogynia*, of

Linnæus. This tree does not rise to any great height, the trunk soon dividing into large

180-1.

Clove Tree.

branches, which are covered with a smooth grayish bark. The leaves are large, entire, oblong, lance-shaped, of a bright green colour, and stand in pairs upon short footstalks.

The flowers grow in bunches at the very extremity of the branches; when they first appear, which is at the beginning of the rainy season, they are in the form of elongated greenish buds, from the extremity of which the corolla is expanded, which is of a delicate peach-blossom colour. When the corolla begins to fade, the calyx turns yellow, and then red; the calyces, with the embryo seed, are in this stage of their growth beaten from the tree, and after being dried in the sun, are what are known as the cloves of commerce. If the fruit be allowed to remain on the tree after arriving at this period, the calyx gradually swells, the seed enlarges, and the pungent properties of the clove are in great part dissipated. Each berry contains only one seed, which is oval, dark coloured, and of a considerable size. It is a long time before a clove-tree yields any profit to the cultivator; as after repeated trials, it can be safely said that it rarely produces fruit till eight or nine years after being first planted.

The whole tree is highly aromatic, and the foot-stalks of the leaves have nearly the same pungency as the calyx of the flowers. "Clove-trees," says Sir T. Raffles, "as an avenue to a residence, are perhaps unrivalled—their noble height, the beauty of their form, the luxuriance of their foliage, and above all, the spicy fragrance with which they perfume the air, produce, on driving through a long line of them, a degree of exquisite pleasure only to be enjoyed in the clear light atmosphere of these latitudes."

The clove is a native of most of the Molucca islands where it has been produced from the earliest records, so abundantly, that in exchange for their spicy produce, the inhabitants were enabled, before the intrusion of the Europeans into their country, to procure for themselves the productions which they required of almost every other region. Although Europeans have for more than two thousand years known the use of this spice, yet little more than three hundred years back they were ignorant whence it was obtained. The Persians, Arabians, and Egyptians formerly brought cloves and nutmegs to the ports in the Mediterranean, and hither the Venetians and Genoese resorted to buy the spices of India, until the Portuguese, in 1511, discovered the country of their production. This nation did not, however, long enjoy the fruits of its discovery; the Dutch soon drove them from the Moluccas, and for a long time maintained a very strict monopoly over the productions of these islands. It is said that they destroyed the clove trees growing on the other islands, and confined their culture wholly to Amboyna. They allotted to the inhabitants four thousand parcels of land, on each of which it was expected that one hundred and twenty-five trees should be cultivated; and in 1720 a law was passed compelling the natives to make up this number: there were in consequence five hundred thousand clove trees planted in this small island, each of these on an average produced annually more than two pounds of cloves, so that the aggregate produce weighed more than a million of pounds. Subsequently to this period, the policy of the Dutch somewhat relaxed, and the tree has been suffered to grow on other islands, and even to be carried to the West Indies, where, however, it does not appear until very lately to have succeeded. Sir Joseph Banks introduced it into this country about 1797.

The clove seems to have been unknown as an aromatic spice to the ancients, neither the Greek nor Roman writers having taken any notice of it. The Arabians first introduced it as a medicine. The essential oil is used as one of the most powerful stimulants in cases of gout or cramp of the stomach, or of paralysis. It will also be found a useful ingredient to allay the pain of a carious tooth, when inflammation of the membranes or gums is not present. Cloves, in substance, are also used as condiments in preserves and pickles.

Cloves contain a very large proportion of essential oil, larger perhaps than any other plant or parts of a plant. This oil is extremely pungent, and is one of the few essential oils which is specifically heavier than water. It is usually procured by distillation, but when the cloves are newly gathered, it may be obtained by pressure. A part is often so taken, and the cloves, which are thereby rendered of little value, are fraudulently mixed with sound ones; but the robbed

cloves are easily detected by their pale colour, shrivelled appearance, and want of flavour.

The pungent and aromatic virtues of the clove reside in this essential oil, combined with the resinous matter of the spice; but it does not appear that these qualities are absolutely necessary to the growth or fructification of the tree. To give to this its greatest value, it must, however, be cultivated in a situation where they can be elaborated in the greatest quantity. Its profitable growth is therefore limited to a very narrow range of temperature and climate; as the clove loses its flavour if the situation be too moist or too dry, too near the sea, or too much elevated above its level. Though the tree be found in the larger islands of Eastern Asia, and in Cochin China, it has there little or no flavour. The Moluccas seem to be the only places where the clove comes to perfection without cultivation.

This tree is so great an absorbent of moisture that no herbage will grow under its branches; while the cloves, when gathered, if placed in a heap near a vessel of water, are found very much to have increased their weight at the end of only a few hours, in consequence of the large portion of water which they have attracted and imbibed. It is said that both the grower and trader in cloves avail themselves of the knowledge of this fact, and since this spice is always sold by weight, thus give a factitious value to their goods.

Pimento or Jamaica Pepper *(myrtus pimenta.)* This is another species of the same

182.

Pimento.

family. It is an extremely handsome tree; a native of South America and the West Indies, especially of the island of Jamaica, whence the berries or pimento of commerce are exported in large quantities. This tree grows to the height of about thirty feet, with a smooth brown trunk, and shining green leaves, resembling those of the bay; branches, coming out on all sides, are clothed in the most luxuriant foliage. In the months of July and August a profusion of white flowers pleasingly contrast with the dark green leaves—the whole forming an object of vegetable beauty rarely surpassed; while the rich perfume which is exhaled around, and which is wafted by the gentlest breeze, renders an assemblage of these trees one of the most delicious plantations of even a tropical clime. When the leaves are bruised, they emit a fine aromatic odour as powerful as that of the fruit; indeed it is said that they yield by distillation a delicate oil, which is often used in the dispensaries as a substitute for oil of cloves.

The pimento tree grows spontaneously in many parts of Jamaica; it abounds more particularly on the northern side of that island, in elevated spots near the coast. When a new plantation of these is to be formed, no regular planting or sowing takes place; it is usual to appropriate a piece of land either in the neighbourhood of a plantation already formed, or in a part of the woodlands where these trees are scattered in a native state. The land is then cleared of all wood but these trees, which are left standing, and the felled timber is allowed to remain where it falls to decay and perish. In the course of a year young pimento plants are found springing up on all parts of the land; produced, it is supposed, in consequence of the ripe berries having been scattered there by the birds, while the prostrate trees protect and shade the tender seedlings. At the end of two years the land is thoroughly cleared, only those plants being left which promise a vigorous growth; these come to maturity in about seven years from the first formation of the plantation, and usually attain to the height of thirty feet. But though apparently of so easy propagation, it is only in those parts where the tree is of spontaneous production. Edwards observes, that "this tree is purely a child of nature, and seems to mock all the labours of man, in his endeavours to extend or improve its growth: not one attempt in fifty to propagate the young plants, or to raise them from the seeds, in parts of the country where it is not found growing spontaneously, having succeeded." The tree was introduced into this country in the early part of last century, but the fruit does not ripen. It is delicate and difficult to manage, requiring at the same time warmth and a great deal of air.

The flowers scarcely fade and give place to the berries, ere these are fit for gathering; since, if the fruit be suffered to ripen on the tree, it loses its pungency and becomes valueless. While yet green, therefore, the berries are carefully picked by hand; one person on the tree gathers the small branches; and three others, usually women and children, find full employment in picking the berries from these. The produce is then spread on terraced floors, and exposed to the action of the solar heat for about a week; in the course of this time the berries loose their green hue, and become of a reddish brown. When perfectly dry, they are in a fit state for exportation.

In a favourable season the pimento crop is enormous. "A single tree has been known to yield one hundred and fifty pounds of the raw fruit, or one hundred weight of the dried spice; there being commonly a loss in weight of about one-third in curing." This return is not, however, of very usual occurrence, as the produce is variable; a very plenteous harvest seldom occurring above once in five years. This spice is chiefly imported from Jamaica, hence the name Jamaica pepper.

Pimento also combines the flavour and properties of many of the oriental spices, hence its popular name of *all-spice.*

THE NUTMEG TREE *(myristica moschata).* Natural family, *myristicæ; diœcia, monadelphia,*

183.

Nutmeg.

of Linnæus. This tree attains the height of thirty feet, producing numerous branches. The bark of the trunk is a reddish brown, that of the young branches is of a bright green colour. The leaves are nearly elliptical, pointed, undulated, obliquely nerved; on the upper side, of a bright green, on the under, whitish; the male and female flowers are on different trees.

The flowers of both are small, white, bell-shaped, and without any calyx; the embryo fruit appearing at the bottom of the female flower, in the form of a little reddish knob. The female flowers grow on slender peduncles, two or three together, but it is rare that more than one flower in each bunch comes to maturity and produces fruit; this resembles in appearance and size a small peach, but it is rather more pointed at both ends. The outer coat is about half an inch thick when ripe, at which time it bursts at the side and discloses the spices. These are—

The *Mace,* having the appearance of a leafy net-work of a fine red colour, which seems the brighter by being contrasted with the shining black of the shell that it surrounds. In general, the more brilliant its hue, the better is its quality. This is laid to dry in the shade for a short space; but if dried too much, a great part of its flavour is lost by evaporation, while it is also more apt to break in packing. On the other hand, if packed too moist, it either ferments or breeds worms. After being dried, it is packed in bags and pressed together very tightly.

The *Nutmeg.* The shell is larger and harder than that of a filbert, and could not, in the state in which it is gathered, be broken without injuring the nut. On that account the nuts are successively dried in the sun, and then by fire-heat, till the kernel shrinks so much as to rattle in the shell, which is then easily broken. After this, the nuts are three times soaked in sea-water and lime; they are then laid in a heap, where they heat, and get rid of their superfluous moisture by evaporation. This process is pursued to preserve the substance and flavour of the nut, as well as to destroy its vegetative power. Dry lime is the best package for nutmegs.

There are two varieties, the royal and the green. The royal is the largest, and it produces mace longer than the nut; on the nut of the green the mace only reaches half-way down. A good nutmeg should be large, round, and heavy, of a light gray colour, and finely marbled in the cross section.

Oil of nutmegs is obtained by pressure from the broken kernels; a pound of them generally yields three ounces of oil. According to Neumann's experiments, the oil produced is one third of the weight of nutmeg; it is yellow, of the consistence of tallow, and of a pleasant smell. This is a fixed oil, but a transparent volatile oil may likewise be obtained by distillation, in the proportion of one thirty-second part of the weight of nutmeg used.

The nutmeg is likewise a native of the Moluccas, and after the possession of these islands by the Dutch, was, like the clove, jealously made an object of strict monopoly. Actuated by this narrow-minded policy, the Dutch endeavoured to extirpate the nutmeg-tree from all the islands except Banda; but it is said that the wood-pigeon has often been the unintentional means of thwarting this monopolizing spirit, by conveying and dropping the fruit beyond these limits; thus disseminated, the plant has been always more widely diffused than the clove. This tree grows in several islands in the Eastern ocean, in the southern part of both peninsulas of India, and it has been introduced into the Mauritius, and some other places. It was for a long time supposed that though the plant could be transplanted, the peculiar aroma of the nut, which gives to the tree its commercial value, was weakened, if not entirely lost, when this was removed from its native soil, and that as a spice-producing tree, it, as well as the clove, was confined to the same narrow locality to which the clove was said to be restricted. In Sumatra, however, it has been successfully cultivated to a large extent. Sir Thomas Raffles gives an

account of the plantation at Bencoolen in 1820: "Out of the number of one hundred thousand nutmeg trees," he writes, "one-fourth are in full bearing, and although their culture may be more expensive, their luxuriance and produçe are considered fully equal to those of the Moluccas." An attempt has been made at Trinidad to naturalize there the clove and the nutmeg; and very recently samples of these spices produced in that island have been transmitted to England for the inspection and approval of the Society for the Encouragement of Arts, &c. The opinions of the best judges have been taken with respect to their quality as compared with the Oriental produce, and, in consequence of a most favourable report, the gold medal of the society has been awarded to the western cultivator of these spices; while sanguine hopes are entertained that the clove and the nutmeg will one day be perfectly acclimatized in the tropical regions of the western hemisphere. The nutmeg tree, as well as the clove, was introduced into this country by Sir Joseph Banks, as an ornamental hothouse plant.

Black Pepper *(piper nigrum).* Natural family, *piperaceæ; diandria, trigynea,* of Linnæus.

184.

Black Pepper.

There are a number of species in the family *piperacea,* all possessing more or less of the warm aromatic qualities for which the common kinds are distinguished. The black pepper is a perennial plant, found native upon the slopes of mountains in the southern parts of both the Indian peninsulas, especially on the coast of Malabar. It is likewise cultivated to a great extent in Sumatra, Java, and the adjacent places. Pepper at one time formed the principal export from Java; it was chiefly cultivated in Bantam, and likewise in the dependencies of that province in the southern part of Sumatra; these districts producing the greater part of the supply exclusively furnished by the Dutch to the European market. It is, however, a satisfaction to find, that the greedy spirit which would appropriate all to self, may sometimes, in its unjust efforts to secure this end, defeat its own purpose. We learn from Sir T. S. Raffles, that "the system by which pepper was procured, was too oppressive and unprincipled in its nature, and too impolitic in its provisions, to admit of long duration. It was calculated to destroy the energies of the country, and with them the source whence the fruits of the monopoly proceeded. In the year 1811, accordingly, neither Bantam nor its dependencies furnished the European government with a single pound of this article."

The system of raising pepper in Java is now, however, completely changed; there is no longer a monopoly, and the cultivation of pepper has for the last few years been declared free.

This plant was introduced some time back at Cayenne, by General Bernard, who has with unceasing perseverance attended to its cultivation in that settlement, in the hope of making the French independent of foreign supply for its produce. It is said that he has already formed a plantation of more than thirty thousand pepper trees on his estate.

The pepper-plant, or pepper-vine, as it is sometimes called, is a creeping or climbing plant, with a dark coloured stem, which requires support; and it is usual to plant a thorny tree by the side of this plant, to which it may cling. In Malabar, the chief pepper country of India, the jacca tree *(artocarpus integrifolia)* is made thus to yield its support, because the same soil is well adapted to the growth of both plants.

The stem of the pepper plant entwines round its support to a considerable height; the flexile branches then droop downwards, bearing at their extremities, as well as at other parts, spikes of green flowers, which are followed by the pungent berries; these hang in large bunches resembling in shape those of grapes, but the fruit grows distinct on little stalks like currants. Each berry contains a single seed, which is of a globular form and brownish colour, but changes to nearly a black when dried; this is the pepper of commerce. The leaves somewhat resemble those of the ivy, but they are larger, and of rather a lighter colour; they partake strongly of the peculiar smell and pungent taste of the berry.

The plant is propagated by shoots, which do not produce fruit the first three years; the fourth year they come into bearing, and yield an increase of produce annually until the eight year of their growth; they then gradually decline, and rarely bear for more than two or three years longer. When in full vigour, the pepper plant is very prolific; each bunch usually contains from twenty to thirty berries, and sometimes as much as six or seven pounds of pepper are obtained from one tree. The time of the pepper harvest on the western coast of Sumatra is usually about September and October, and sometimes another smaller crop is gathered in March and April. The pepper plantations on this island are described as being most carefully cul-

tivated; not a weed is to be seen, every species of litter is removed, and if the season be dry, the plants are watered with unremitting assiduity.

The black and white sorts of pepper are both the produce of the same plant; the best white peppers are supposed to be the finest berries which drop from the tree, and lying under it become somewhat blanched by exposure to weather—these the poor people pick up and bring to the merchants; they are, however, obtained in very small quantities, and are on that account, as well as for their superior quality, sold much dearer than the gathered pepper, which pepper was formerly thought to be a different species from the black; and at the East India sales used to bring them twice the price of the other. The greater part of the white pepper used as a condiment, is, however, the black merely steeped in water and decorticated, by which means the pungency and real value of the pepper are diminished; but in this state it can be more readily reduced to powder, and, when thus prepared, it has a fairer and more uniform appearance.

The pepper is distinguished in Sumatra into three sorts: the *molucca*, which is the best; the second, *caytongee;* and the worst sort, *negaree*, which last is the most abundant; this is a small pepper usually full of dust; it is much lighter than the others, and therefore, unless the buyer be wise enough to purchase his pepper by weight instead of measure, he will assuredly be imposed upon, and have this substituted for the heavy Molucca berry.

By distillation a green-coloured matter is obtained from pepper; this is partly resinous, and partly oily, and to this the pepper owes its pungent quality.

Long Pepper (p. longum). The roots of this species are perennial; the stems are shrubby,

185.

Long Pepper.

round, smooth, branched, slender, and climbing, but do not rise to any considerable height. The leaves differ much in size and form; they are commonly heart-shaped, pointed, entire, smooth, nerved, of a deep green colour, and stand alternately upon footstalks; the flowers are small, and produced in short, dense, terminal spikes, which are nearly cylindrical. The berries or grains are very small, and lodged in a pulpy matter like those of the black pepper; they are first green, and become a dark red or black, when ripe.

It is a native of Java, Malabar, and Bengal. It is most pungent when gathered in its green state, before full maturity. It is afterwards dried in the sun, and assumes a black colour.

Cajeput Tree *(melaleuca leucodendron).* Natural family *myrtaceæ; polyad lphia, polyandria*, of Linnæus. This tree rises with a long flexible trunk, sending off irregular ascending branches, covered with a pale, thick, lamellated, tough bark. The leaves are linear, lanceolate, entire; of an ash colour, and placed alternately on short footstalks. The flowers are sessile, white, and in the form of a long spike. This tree is a native of India, and yields the aromatic oil known under the name of cajeput oil. The leaves, which have a highly aromatic odour, yield by distillation this oil. It is highly volatile and stimulating, resembling in odour camphor, or rosemary, or the odour of cardamom seeds.

It is imported into Europe from the East Indies; and is distilled chiefly in the island of Banda. It is used in medicine as a powerful stimulant and antispasmodic, and seems similar in its effects to the others. The dose is from two to twelve drops. Externally, it is employed in rheumatic pains.

Cardamom *(amomum repens).* Natural family *scitameneæ; monandria, monogynia*, of Linnæus. This is a perennial herbaceous plant, with an erect, sheathy stalk, and lanceolate leaves. The flower stalk proceeds immediately from the root, and creeps along the ground; it is commonly about a foot and a half in length, with numerous small white flowers. Several small dark-coloured seeds are contained in a triangular capsule. It is a native of the East Indies, and grows abundantly on the Malabar coast. There are several species, or perhaps varieties, distinguished chiefly by the size of the seeds.

The lesser cardamom is that usually imported into this country. These seeds contain an aromatic oil, and mucilage, both which is readily given out in aqueous infusions. Their flavour is agreeable, and similar to the other camphoraceous plants. The seeds are used chiefly in medicine.

Caraway, *carum carui; pentandria, digynia*, of Linnæus. This is a well known plant, of the family umbelliferæ. It is a biennial, and bears its seeds the second year. The stem and leaves of this plant have a sweetish, aromatic taste; and the seeds contain a pleasant aromatic oil, which is obtained by distillation. The seeds are used in confectionaries; and both they and the oil are carminative, and gently stimulating.

Ginger, *zingiber officinale; monandria, mono-*

gynia, of Linnæus, is a native of the south-east of Asia and the adjacent isles. It was naturalized

186.

Ginger.

in America very soon after the discovery of that country by the Spaniards; indeed, at so early a period that it is scarcely believed to be an exotic, and is supposed to have been found indigenous in the Western World. Acosta relates that a person named Francisco de Mendoza, first transplanted it from the East Indies into New Spain, where its cultivation was diligently pursued by the Spanish Americans to no small extent, as, from the testimony of the same author, 22,053 cwt. were exported thence to Europe in the year 1547.

The plant is now cultivated in great quantities in the West Indies, especially in the island of Jamaica. Ginger is imported into this country under the form of dried roots, and as a preserve. We receive it both from the East and West Indies, but that from the latter is much superior in quality to the former. British plantation ginger pays eleven shillings per cwt., import duty, and all other is not admitted under fifty-three shillings per cwt.; these two causes unite in confining the home consumption of ginger almost entirely to that coming from the West Indies.

The ginger plant has been cultivated in this country as a stove exotic since about the year 1600. It has a perennial root, which creeps and increases under ground in tuberous joints, from each of which arises in the spring a green reed-like stalk of about two feet and a half in height, having narrow and lanceolate leaves. The stem is annual; the flowering stalk rises directly from the root, ending in an oblong scaly spike; from each of these scales a single white and blue flower is produced. The ginger of commerce is distinguished into black and white; but the difference of colour depends wholly on the modes of preparation. For both of these kinds the tubers are allowed to be ripe, that is, the roots are taken up after the annual stalks are withered. For the black, they are scalded in boiling water, and then dried in the sun; and for the white, they are scraped clean and dried carefully without being scalded. The best and soundest roots are selected for the latter process, and therefore white ginger is, independent of the manner of preparation, superior to the black, and it always bears a much higher price in the market. When a preserve is to be made of the roots, they are dug up in the sap, the stalks not being more than five or six inches long. For this purpose the young roots are scalded, then washed in cold water, and afterwards carefully peeled. This process lasts for three or four days, during which period the water is frequently changed.

When the cleansing is complete, the tubers are put into jars, and covered with weak syrup of sugar. After a day or two the weak syrup is removed, and replaced by a stronger; and the shifting is two or three times repeated, increasing the strength of the syrup each time. The preserve thus formed is one of the finest that is made; and the removed syrups are not lost, but fermented into a pleasant liquor, which gets the name of "cool drink."

THE CAPSICUM (natural family *solaneæ)*, is a native of tropical regions, but is become so far

187

Capsicum.

acclimatised in this country as to be successfully reared, and during summer to endure the open air uninjured.

Three species of capsicum are cultivated in England.

The Guinea Pepper (capsicum annuum), was introduced into England, from India, so early as 1548, and is mentioned by Gerarde as being under cultivation in his time. This plant has a branchy stem, rising about two feet high; the leaves are long, narrow, and of a dark green colour. White flowers bloom in June or July, and are succeeded by pods varying in shape and colour; some being long, others short, some round, and others again heart-shaped, while the colour is either red or yellow.

The *Cherry Pepper (capsicum cerasiforme)*, is a native of the West Indies, and was not

cultivated in England until 1759. This species is very similar in appearance to the first, and is only characterised by the different shape of the pods, which take somewhat the form of a cherry; sometimes heart-shaped, bell-shaped, or angular; their colour is the same as the preceding. Both these species are annuals.

The *Bell Pepper (capsicum grossum)*, is a biennial, a native of India; it produces larger pods than either of the others. It may be transplanted with safety in the open garden, on the arrival of summer, requiring a place in the stove during the winter season.

The green pods of all these varieties are used for pickling; those of the last are generally preferred, being not only larger, but having the skin more pulpy and tender.

Cayanne Pepper *(c. baccatum)*, commonly called bird pepper, is gathered when ripe, dried in the sun, pounded and mixed with salt; it is then kept stopt in bottles, and is known under the name of *cayanne.* There are many other species of this genus, differing from each other in bearing fruit of various size, shape, and colour; but they all have, in a certain degree, the same pungent qualities; the smallest possessing them with the greatest intensity. They are natives of most of the tropical regions, but are most abundant, and most used in the western hemisphere. In the West Indies, and in some parts of South America, they form, either in substance or in powder, an ingredient to almost every dish.

A mixture of sliced cucumbers, shallots, or onions, cut very small, a little lime juice, and Madeira wine, with a few pods of bird pepper well mashed, and mixed with the liquor, is reckoned an unfailing stimulant to the appetite in the West Indies, and is called *man-dram.*

The Caper *(capparis spinosa); polyandria, monogynia*, of Linnæus, is a native of Italy and

188.

Caper Plant.

Sicily. It was introduced into this country as an exotic so early as 1596. Modern horticulturists are of opinion that with care it might be raised in the open air in England, but this has never yet been accomplished to any useful extent. One instance, indeed, is recorded by Neill, of a caper tree standing alive in the open air for nearly a century; this was in the garden at Campden House, Kensington. This plant was sheltered from the north, and remained uncovered during winter. It was generally much injured by frost; but the roots being particularly strong and vivacious, it sent out strong shoots, and produced flower buds every year. In France the caper tree has been long naturalized, being cultivated in the vicinity of Paris with no other shelter than a low wall, against which it is trained; in winter, the shoots are laid down, and covered with litter or fern. Near Toulon it is not trained in this manner, but overspreads the ground in the manner of brambles. It is a trailing shrub, and in the southern parts of Europe, where it is found native, grows very abundantly out of the joints of old walls, the fissures of rocks, and amongst ruins. The stem is ligneous, sending out many lateral branches; the shoots rise two or three feet, and then become procumbent. From under each of the branches proceed two crooked spines; immediately above these the petioles of the kidney-shaped leaves are produced. White flowers, growing on long peduncles, would, if allowed to remain, bloom through the summer; but before they expand, their buds, with the empalements, are plucked and used for pickling. A large quantity of these, which form a well known pickle, is annually imported into England, from Italy and ports in the Mediterranean.

Indian Cress or Nasturtium *(tropeolum majus and minus.) Octandria, monogynia*, of Linnæus. This plant is a native of Parma, where it is a hardy perennial. In this country, though it thrives well in the open air, it only lasts for one season, being unable to endure the cold of winter.

There are two species, the small and large nasturtium, the latter of which is the hardiest, and that usually cultivated. They will thrive in almost any soil, but prefer a light fresh loam; as the plant is a creeper, it requires to be trained to a fence, wall, or trellice. The seeds are employed as a pickle, and are used as a substitute for capers, many preferring them to that seed. The flowers and under leaves are also eaten as sallads. There is a variety with double flowers, which is propagated by cuttings. The daughter of the celebrated Linnæus observed, that in the evening these flowers emit spontaneously at certain intervals visible electric sparks.

This plant was introduced into Britain in 1686, and is very commonly cultivated in gardens, both for show and use.

The Labiatæ, a natural family of plants which are found chiefly in the temperate regions of the globe, is remarkable for containing numerous genera possessing an aromatic odour and pungent flavour. They owe this quality to the

existence of an aromatic oil, which they yield in distillation. This oil differs in its odour according to the species from which it is procured; but the essential ingredient of the whole tribe is camphor, or a matter very nearly allied to this substance, which, as we have seen, is found in such abundance in tropical plants.

A large proportion of the labiatæ are natives of Britain; some are mere weeds, and others useful herbs; all are perfectly harmless; and to them we owe much of the fragrant odour of our fields and meadows. Thus we have on our dry heaths and downs the sweet-smelling thyme, the balmy calamint, the rosemary, and many others, while the peppermints correct the chill and pestilent odours arising from marshes and stagnant pools.

The mints, thyme, rosemary, sage, basil, marjoram, and several others, are employed in giving an odour to various meats.

Mint *(Mentha)*. There are numerous species of this genus, three of which are commonly used.

Peppermint (m. piperita), has oboval, pointed, and serrated leaves, a strong aromatic smell, and pungent penetrating taste, succeeded by a sensation of coldness. It is chiefly used for obtaining oil of peppermint by distillation, and for this purpose is extensively cultivated in low, rich, and marshy lands. To keep up its quality, the roots are transplanted every three years. The leaves must be pulled in dry weather.

Spearmint (m. viridis), has lanceolate leaves finely serrated. The odour is less strong and heavy than that of peppermint, and the taste less pungent. It is used to give flavour to food, and as a stomachic. An infusion of the leaves retards the coagulation of milk. For medicinal purposes, the leaves should be gathered in dry weather, just as the flowers appear. For distillation, the flowers are allowed to blow.

Pennyroyal Mint (m. pulegium). This is a trailing plant, with small, smooth, ovate leaves. The odour is less pungent than that of the others, the bark is pungent and aromatic. It is used for the same purposes as the others.

Thyme *(thymus)*. Two species are found natives of Britain, the *thymus serpyllum* and *thymus acinas;* but that which is cultivated in our gardens, *thymus vulgaris*, is a native of Spain, and other parts of southern Europe. The climate of Spain seems peculiarly genial to the growth of all sweet herbs. At Marvella, about midway between Malaga and Gibraltar, De Laborde speaks of "sage, thyme, marjoram, lavender, myrtle, and rosemary, more than *six feet high*, embalming the air on all sides." Thyme was introduced into this country certainly before the middle of the sixteenth century, but how long previous to that period is not ascertained. This herb is well known as a low shrubby evergreen, of a strongly aromatic odour. When of the largest growth it scarcely attains to a foot in height. Its minute leaves are smooth and oval, and the flowers are smaller than those of the wild thyme. Three varieties are usually cultivated, and distinguished as the broad, the narrow, and the variegated leaved.

Two or three tufts of another species, the lemon thyme, *thymus citriodorus*, sometimes find a place in the herb compartment of the kitchen-garden. This is a trailing evergreen, of still smaller growth than the common kind, and is remarkable for its smell, which resembles that of the rind of lemons, whence its distinctive name. Both the species thrive best in a dry soil. They are propagated most generally from seed; but they can likewise be multiplied by slips, or by parting the roots.

This herb is used in many savoury preparations. It was employed by the Romans to give its peculiar aromatic flavour to cheese; a practice pursued likewise with some flowers and seeds of other plants. This manner of preparing cheese was still continued during the middle ages. We collect this from an anecdote told of Charlemagne, who, travelling unattended, arrived at a bishop's palace. It was unfortunately a fast-day, and the only fare which the bishop would set before his royal guest was bread and some choice cheese; this the king did not appear particularly to relish, picking out with his knife small specks, which he mistook for unsound parts, but which in fact were parsley seeds. The prelate ventured to hint that he was throwing away the best parts of the cheese; when the monarch tasted it, and liked it so much, that he requested the bishop to send him an annual supply of this excellent flavoured curd; and, lest the cheese-merchant might by chance pack cheeses without any admixture of seeds, the king desired that they might always be cut in two, in order to ascertain the fact, and be then fastened together again with a skewer. The mountaineers in the canton of Glaris in Switzerland, prepare a cheese known by the name of Schabzieger, which is readily distinguished by its peculiar marbled appearance and aromatic flavour; these are communicated by the pressed flowers or the bruised seeds of the *melilotus officinalis.*

Sage *(salvia officinalis)*, is a native of the warmer parts of Europe, but it has long been cultivated in Britain. Gerarde notices it as being, in 1597, a well known herb of the English garden. It is a hardy plant, but, though a perennial, does not last above three or four years without degenerating. New plantations are readily made by cuttings of the young shoots taken in the latter end of spring.

This aromatic herb is chiefly used with the more strong and oily kinds of food, as a mixture in stuffings, and an ingredient in sauces. The

leaves are sometimes introduced into English cheese.

A species of sage *(salvia pomifera)*, of a very peculiar growth, is common to some of the Greek islands. It has firm fleshy tumours, of about three quarters of an inch in thickness, swelling out from the branches of the plant, and supposed to be produced in the same manner as oak apples, by the puncture of an insect of the cynips genus. These excrescences are semi-transparent, like jelly. They are called sage apples, and under that name are always to be met with in the markets, as an article of ordinary sale. They are made into a kind of conserve, which is highly esteemed by the Greeks. Dr Clarke, in the sixth volume of his travels, mentions having been regaled with this delicacy by the English consul, at the island of Syros, and he bears testimony to its excellence. This plant is considerably larger than the common sage of our gardens, and its flavour and smell are much more powerful. It grows very abundantly in Candia, Syros, and Crete, where it attains to the size of a small shrub.

Clary *(salvia sclarea)*, is a biennial plant, a native of the south of France, of Switzerland, and of Italy. It was first introduced into English cultivation in the year 1562.

Marjoram *(origanum)*. The common marjoram, or *origanum vulgare*, is a native of Britain; it is a perennial under-shrub, growing among copsewood in calcareous soils. The leaves are small and acute. The flowers are slightly red, and appear in July and August, in smooth clustered spikes.

The *Winter marjoram (origanum heracleoticum)*, very much resembles the above species in appearance; but it is of a more aromatic flavour, and is always used in preference. It is indigenous to Greece, whence it was introduced into this country in 1640. A sheltered, dry situation is most favourable to its growth. The seeds of this, and of the two following species, seldom come to maturity in England. Winter marjoram is, therefore, usually propagated by cuttings.

Sweet Marjoram (origanum majoranum), was an inhabitant of the English garden about seventy years prior to the first cultivation in this country of the above species. It is a biennial, having its flowers growing in close knotted-like heads. As soon as it blossoms, this plant is cut and dried for winter use; it must be renewed by seed annually, for which purpose the seed is imported from France and Italy into England.

Pot Marjoram (origanum onites), was not introduced into English cultivation until the middle of the last century. It is a hardy perennial, with a hairy stem, rising to more than a foot high; it blooms from July to November, and is usually propagated by cuttings.

Basil *(ocymum)*, is rich in aroma, its odour and pungency being very similar to those of cloves. It is a favourite herb among French cooks, as giving an additional zest to highly seasoned dishes. The leaves in small quantities are sometimes mixed in salads, or are made a flavouring ingredient in soups.

Balm *(melissa officinalis)*, is a native of the south of France, and was introduced into this country in 1573. It is a hardy perennial.

Balm was long famed for its medicinal virtues; and although it has ceased to be invested with its former supposed potent qualities, it still retains a kind of posthumous fame, and "balm" has become the generic name for a soothing healer of wounds, both of the body and the mind. Balm was the plant which the adept Paracelsus selected from which to prepare his *elixir vitæ*, his *primum ens melissæ*, whereby he was to renovate man; and, if he did not bestow on him absolute immortality, to produce a very close approximation to that state. Such strange conceits of ill-directed minds have, however, long gone by; and balm, stripped of its fancied virtues, is now only employed as an infusion in preparing a cooling drink, or in giving flavour to a weak factitious wine.

Rosemary *(rosmarinus officinalis)*. This is a hardy evergreen under-shrub, a native of the south of Europe. The stalk attains the height of six or eight feet; the leaves are sessile, long, narrow, entire, obtuse; upper surface dark green, under a silvery gray, placed in whorls upon the branches: the flowers are large, of a pale blue colour, and arise from the axillæ of the leaves. The whole plant is aromatic, and the flowers by distillation yield a strong essential oil. The flowers form a principal ingredient in the distillation of Hungary water. In some parts of the west of England and in Wales, sprigs of rosemary are distributed to the company at funerals as tokens of remembrance, and often thrown into the grave upon the coffin of the deceased. The varieties are the green, or common, the gold-striped, and silver-striped. The green is the best and most easily raised.

The Costmary, or Alecost *(balsamita vulgaris)*, an herbaceous plant resembling in odour the rosemary, though belonging to a different family *(compositæ)*, may here be properly introduced.

It is a hardy perennial, a native of Italy, introduced into this country in 1568, and common in almost every rural garden. The name implies that it is the *costos*, or aromatic plant of the Virgin Mary. In France it is used in salads and was formerly put into ale and negus; and hence the name of alecost. In this country it is now little used, except for the pleasing fragrance of the leaves in a nosegay.

Lavender *(lavandula spica)*. This is a hardy

under-shrub of the family *labiatæ*, a native of the south of Europe, and introduced into Britain in 1658. The leaves and flowers are highly aromatic, and produce by distillation the well known oil of lavender, so much esteemed as a perfume. The leaves, and especially the flowers, are collected, dried, and put into places where linen is kept, to impart to it their odour. It is of easy culture, and prefers a dry, rather sandy soil, in which situations the odour of the flowers is greatest.

Tansy *(tanacetum vulgaris)*. This is a perennial plant, growing on the sandy banks of rivers in many parts of Britain. It belongs to the family *compositæ* and *syngenesia*, of Linnæus. The young leaves, which partake of the aromatic flavour of the plants of the *labiatæ*, are used in cookery. The flowers have a pungent, aromatic odour.

Samphire *(crithmum maritimum)*. Natural family *umbelliferæ; pentandria, digynia*, of Linnæus. The common samphire is a perennial plant, a native of Britain, and grows on rocky cliffs by the sea side, and on dry stone walls. The root leaves are triternate, those of the stem lanceolate and fleshy; the flowers appear on a stem of about eighteen inches high in August, and are of a yellow colour. The name is a corruption of the French *Saint Pierre*.

It forms an excellent pickle, and a frequent addition to salads. In taste it is crisp and aromatic, and constitutes a light and wholesome condiment. It was at one time much more extensively used than now, when many other foreign aromatics have been introduced into this country.

CHAP. XLVII.

TREES AND PLANTS USED IN DYEING.

The nature of vegetable colouring matter, and the principal products of this kind obtained from the vegetable kingdom, have already been noticed in the twenty-first chapter of this work: we now proceed to describe those trees, shrubs, and herbaceous plants which yield the several kinds of dyes.

The Logwood Tree *(hæmatoxylon campechianum)*. Natural family *leguminosæ; decandria, monogynia*, of Linnæus. This tree is a native of South America, and does not attain a height above twenty to twenty-five feet. Both the trunk and branches are extremely crooked, and covered with a dark coloured, rough bark. The smaller ramifications are numerous, close, prickly, or beset with strong sharp spines. The leaves are pinnated, generally composed of four or five pairs of leaflets, of an irregular, oval shape, obliquely nerved, and obtusely sinuated at the top. The flowers are yellow, and grow in

189.

Logwood.

racemes, or in close, regular, terminal spikes, and appear in March: these are followed by long, double-valved pods, containing oblong, compressed, and somewhat kidney-shaped seeds.

This tree is of rapid growth, and very easily propagated; so that under cultivation a flourishing plantation may be formed in a few years. It thrives best in marshy ground; but this ground must not be always under water. Trees of full growth are from sixteen to twenty-four feet in height, and from five to six feet in circumference.

This tree was first discovered in the bays of Campeachy and Honduras, growing in the greatest luxuriance and abundance. It was known as a dye-wood as early as the reign of Elizabeth, but its use was forbidden by an act of parliament for "abolishing certain deceitful stuffs employed in dyeing cloths." The act sets forth that "logwood, or blockwood, of late years brought into this realm, is expressly prohibited to be used by dyers, the colours thereof being false and deceitful to the queen's subjects at home, and discreditable beyond seas to our merchants and dyers." The injunction against the use of this valuable dye was rigorously enforced, and all logwood found was seized and condemned to be burnt. The English were probably at that time ignorant of the manner of applying this dye with proper mordants. The prohibition was continued until the year 1661, the words of the act by which it was then repealed stating "that the ingenious industry of these times hath taught the dyers of England the art of fixing colours made of logwood; so that by experience they are found as lasting and serviceable as the colour made with any other sort of dye-wood."

Immediately after this repeal logwood became in great request, and adventurous individuals were induced to make exertions to obtain a supply. This tree is one of the productions of the province of Yucatan, where the possessions

of the Spaniards for a long time consisted only of the port of San Francisco de Campeachy, and two other inconsiderable towns, Merida and Valladolid. These could boast of but few inhabitants, and the rest of the province was wholly desolate, without any indication of the abode of man. The English, from the north continent of America, in the year 1662, tempted by the desire of pursuing a profitable occupation, ventured to cut down some of the logwood trees, which grew in great abundance on the uninhabited parts of the coast of Yucatan, and more especially in the bay of Campeachy. These persons soon formed a small colony in a spot remote from any Spanish settlement. They first raised their huts near Cape Catoche, and afterwards at Laguna de Terminos, which was found to be a more eligible situation. A few settlers thus continued to cut logwood unmolested by the Spaniards, but always with the feeling that they were intruders on the soil of other colonists.

After the treaty of Madrid in 1667, which was principally made for adjusting our commerce with Spain in Europe, British subjects were led to imagine that the respective interests of the two countries in the western hemisphere had also been accurately defined by the same treaty, and that the right of the English to cut logwood in those places of the Honduras, uninhabited by the Spaniards, was now clearly established. Many other persons were therefore in consequence induced to become logwood-cutters at Laguna de Terminos, so that in a year or two the number of settlers was greatly increased, and they transported large quantities of wood both to Jamaica and New England. The Spaniards for many years made no expostulations or complaints, and the English logwood-cutters continued to increase and flourish.

At first a sufficiency of wood was found near the coast, but when this, after a time, became exhausted, the settlers gradually penetrated farther into the country, where they planted Indian provisions, and built houses. The jealousy of the Spaniards was at length excited by this growing colony, and suddenly evinced itself very unceremoniously by the seizure of two English ships laden with logwood. The settlers of Laguna immediately made reprisals by taking possession of a Spanish bark. These mutual acts of violence were only the commencement of a series of hostilities, and after suffering much annoyance, the English settlers were, in 1680, forcibly ejected by the Spaniards from the island of Trist, and from Laguna de Terminos. This triumph on the part of their adversaries was, however, but transitory, and in two or three months the English were again cutting their logwood, and trading in it more extensively than ever. Notwithstanding the continued opposition of the Spaniards, the indefatigable settlers still contrived to increase their supply of that article, for whose possession they hazarded so much. Independent of the vexatious warfare by which they were constantly harassed, the lives of these poor wood-cutters were marked with hardship and privation; sometimes they worked up to their knees in water, and they were always tormented by the stings of innumerable insects.

We learn from Dampier that the commodities sent from Jamaica to procure a return cargo of logwood from Campeachy, were rum and sugar, "and very good commodities," says the sailor, "were these for the logwood-cutters, who were then (1675) about 250 men, most English." "Neither was it long," he adds, "before we had these merchants come on board to visit us; we were but six men and a boy in the ship, and all little enough to entertain them: for besides what rum we sold by the gallon or firkin, we sold it made into punch, wherewith they grew frolicksome. We had none but small arms to fire at their drinking healths, and therefore the noise was not very great at a distance, but on board the vessel we were loud enough till all our liquor was spent. We took no money nor expected any, for logwood was what we came hither for, and we had of that in lieu of our commodities after the rate of five pound per ton to be paid at the place where they cut it."

This occasional festivity, a prospect perhaps of making more than by regular labour in the British colonies, and the entire freedom from all restraint, were circumstances likely to recommend the life of a logwood-cutter in spite of its frequent hardships. It had such charms to the adventurous Dampier himself, that he soon returned and settled for ten or twelve months at Campeachy, and left that place with the intention of again returning for a longer stay. He thus quaintly describes the manner in which the logwood men lived.

"The logwood-cutters inhabit the creeks of the east and west lagunes in small companies, building their huts by the creeks' sides for the benefit of the sea breezes, as near the logwood groves as they can, removing often to be near their business: yet when they are settled in a good open place, they choose rather to go half a mile in their canvas to work than lose this convenience. Though they build their huts but slightly, yet they take care to thatch them very well with palm or palmet leaves, to prevent the rains, which are then very violent, from soaking in.

"For their bedding they raise a barbecue, or wooden frame, three foot and a half above ground, on one side of the house, and stick up four stakes, at each corner one, to fasten their curtains; out of which there is no sleeping for moskitoes. Another frame they raise covered with earth for a hearth to dress their victuals; and a third to

sit at when they eat it. During the wet season, the land where the logwood grows is so overflowed, that they step from their beds into the water, perhaps two feet deep, and continue standing in the wet all day till they go to bed again; but nevertheless account it the best season for doing a good day's labour in.

"Some fell the trees, others saw and cut them into convenient logs, and one chips off the sap, and he is commonly the principal man; and when a tree is so thick, that after it is logged, it remains still too great a burden for one man, we blow it up with gunpowder. The logwood-cutters are generally sturdy strong fellows, and will carry burthens of three or four hundred weight; but every-man is left to his choice to carry what he pleaseth, and commonly they agree very well about it: for they are contented to labour very hard. In some places, especially in the west creek of West Lagune, they go a hunting wild cattle every Saturday to provide themselves with beef for the week following. When they have killed a beef they cut it into quarters, and taking out the bones, each man makes a hole in the middle of his quarter, just big enough for his head to go through, then puts it on like a frock and trudgeth home; and if he chanceth to tire, he cuts off some of it, and throws it away."

The hides of these wild cattle, and many which they killed merely for their hides, were another valuable article of commerce to these hardy adventurers. Many of these men made considerable sums of money; and Dampier remarks, generally, that those who had the advantage of some education, were careful to improve their time, industrious and frugal; but that those who did not possess this advantage, "would extravagantly squander away their time and money in drinking and making bluster."

As these settlements continued to be regarded with an hostile eye by the Spaniards, the introduction of the logwood-tree into Jamaica was attempted in 1715. Seeds were procured from Campeachy for this purpose, and the growth of the plants was found to be so rapid, that in three years they attained to the height of ten feet. In a comparatively short period this tree flourished abundantly in the island, large plantations were formed for the purpose of cutting, and the tree has so multiplied, that in the course of years it has become completely naturalized in Jamaica. The wood of Campeachy is, however, prized beyond that of Jamaica. The success attendant on its cultivation in that island, did not, therefore, by any means cause a cessation of the demand for Campeachy wood, and accordingly the cutters still continued to contend with the Spaniards for the right of cutting down these trees.

In the treaty of Utrecht, in 1713, the commercial relations of the two countries in America were not again neglected, and at length the privilege of cutting logwood was confirmed to the English in plain and express terms, so that it was supposed the question was set at rest for ever. It, however, still continued to be a subject of constant dispute between the parties, and, in 1717, the Marquis de Monteleone, then Spanish ambassador-extraordinary at the court of St James, delivered a memorial to the British government against the settlements in the isle of Trist, and at Laguna de Terminos, in the bay of Campeachy, declaring that if, in the space of eight months, these places were not evacuated, the inhabitants should be considered and treated as pirates. This document was submitted to the Board of Trade in England, which, after much investigation, came to the decided opinion that British subjects *were entitled* to cut wood in the bay of Campeachy. Spain reluctantly acquiesced in this positive decision, and the settlement continued without being matter of farther dispute or treaty for more than forty years. During this long period the British settlers had not been idle. Fortifying themselves against the assaults of the Spanish Americans, their colony assumed a more important and imposing aspect, not only having the power to resist, but to resent aggression.

These defensive measures were naturally viewed with alarm by the Spaniards, and in a treaty concluded in 1763, the two countries came to a compromise on this question; the English government consenting that the fortifications erected in the bay of Honduras, and other Spanish territories in America, should be demolished; while the Spanish government engaged that the subjects of Great Britain should not be molested in cutting or shipping logwood.

Notwithstanding the above treaty, the governor of Yucatan in the ensuing year gave great annoyance to the British logwood-cutters in Campeachy Bay, and even drove them from the place, on the pretext that they had no certificate to prove them British subjects; and that, moreover, they made too free with the produce of the country. No time was lost in remitting a remonstrance to the Spanish court, which unreservedly disavowed and disapproved of the conduct of the governor. Positive orders were sent out to that man of office, and the English once more obtained their logwood without molestation. They were not, however, allowed to remain long undisputed occupiers of this coast. The French now attempted to supplant, or to share with them in this lucrative employment, and invaded their privilege by cutting logwood on those parts of the coast, the productions of which had been assigned to the English by the last treaty. Although this had forbidden them to raise fortifications, it had at the same time not only given

to them the right of cutting and shipping logwood, but of erecting houses and magazines, together with the privilege of a free fishery in the adjacent seas, on that part of the coast of the bay of Honduras, which was comprehended between the river Wallis on the south side, and the Rio Nuevo on the Rio Hondo on the north side, the sovereignty of the country still remaining with Spain. The privileged settlers of Campeachy of course treated the French as intruders, and were forced again to contend for the right of being undisputed wood hewers in a tropical morass.

The logwood-tree grows abundantly throughout whole districts in Jamaica. Besides being cultivated as a dye-wood it is used for other purposes. It is found well adapted for making strong full hedges, and is constantly planted for this purpose, no other fences being seen in many parts of the island. It is excellent for fuel, and, according to Dampier, is advantageously used in hardening or tempering steel. The wood of this tree is very hard and heavy; it is of a deep orange red colour; it yields its colour both to aqueous and spirituous menstruæ, but the latter extracts it the most readily and copiously. A decoction of this wood is of deep violet or purple colour, which after a time changes to a yellowish tint, and becomes finally black. Like that of Brazil-wood it is made yellow by acids, and deepened by alkalis. Although an adjective dye,* it can be made very durable by the judicious application of mordants. With alum and tartar it produces a violet dye. With acetate of copper, a fine blue. But its principal use is in dyeing black, to which it gives a superior lustre, and in the production of all the different shades of gray. It contains a large proportion of gallic acid, whence it is that in combination with acetate of iron, the black colour is produced.

Logwood is imported into England in large blocks, at the very small import duty of three shillings per ton; that brought from foreign countries is chargeable with fifty per cent. higher duty.

The average annual importation for the last five years has been 14,092 tons.

The average price for the best logwood during that time has been £8. 10*s*. per ton. Logwood is also occasionally used in medicine as an astringent and tonic, and has been found efficacious in the cure of diarrhœa and dysentery.

Brazilwood *(cæsalpinia)*. Natural family *leguminosæ; decandria, monogynia*, of Linnæus. There are several species of this family natives of South America, and of the East and West Indies. It was probably, however, first imported into Europe from the Brazils, and hence the name. Soon after its introduction the Portuguese government began to appreciate its value, and accordingly it was made one of the objects of royal monopoly, being imported into Europe on account of the crown. From this circumstance it is known in Brazil as *pao de Rainha*, or Queen's wood.

The *cæsalpinia crista*, or oval-leaved species, is commonly found growing in dry rocky situations. Its trunk is large, crooked, and full of knots; at a short distance from the ground innumerable branches spring forth, and extend in every direction in a straggling, irregular, and unpleasing manner. Trees of the largest growth attain to thirty or forty feet high, but they are rarely met with of so great dimensions. The branches are armed with short, strong, upright thorns; the leaves are small, and never appear in luxuriant foliage. The flowers are of a beautiful red colour, and emit a fragrant smell.

When first cut, the wood is a pale red, but becomes darker by exposure to air. It is variegated with irregular and fantastical black spots, which has obtained for it among the French the name of *bois de lettres*. The bark of this tree, which is extremely thick, and the white pithy part, are both useless; the heart being the only valuable portion, and when both within and without are cut away it is diminished to nearly half its bulk. It is a very hard and dry wood. The thickest pieces with a close grain are considered the best. It is sometimes used in turnery, and susceptible of a good polish, but its principal use is as a red dye. The colour which it communicates is however very fleeting. It is an adjective dye, and generally applied in combination with a mordant of alum and tartar, but with different mordants it may be made to assume all the shades allied to red. The most permanent colours produced from this dye are those in which the natural purple red is changed by acids to an orange or yellow colour. Brazil-wood is often used in dyeing silk of a crimson hue, but cannot be made so durable as the cochineal crimson.

Red ink is made of a decoction of this wood in beer, wine, or vinegar, to which a portion

* Dr Bancroft has made a distinction of dyeing substances into two kinds, *substantive* and *adjective*, and thus explains the reason for adopting these terms. "Colouring matter seems to fall naturally under two general classes; the first including those matters which, when put into a state of solution, may be permanently fixed, and made fully to exhibit their colours in or upon the dyed substance, without the interposition of any earthy or metallic basis; and the second comprehending all those matters which are incapable of being fixed, and made to display their proper colours without the mediation of some such basis. The colours of the first class I shall denominate *substantive*, using the term in the same sense in which it was employed by Bacon, Lord Verulam, as denoting a thing solid by, or depending only upon, itself; and colours of the second class I shall call *adjective*, as implying that their lustre and permanency are acquired by adjection upon a suitable basis."

of alum is added, to render its colour less fugitive.

Brazil-wood boiled in water communicates to it a fine red colour, while the wood itself becomes of a darker colour, and if the ebullition be continued long enough the residuum will be black. Paper tinged red with this decoction is altered to a violet colour by the action of the alkalis, and to a yellow by most of the acids. The action of sulphuric acid gas renders it quite white. M. De Bonsdorff, in the "Annales de Chimie et de Physique," details many phenomena of the effects which this colouring matter has on different acids. It is an excellent test to detect the presence of sulphuric acid in vinegar. In pure acetic acid it receives only a violet tinge, but the admixture of only one two-hundreth part of sulphuric acid will give the stained paper a yellowish instead of a violet hue.

In two decoctions made with equal weights of madder and of Brazil-wood, only half the quantity of chlorine gas, which will destroy the colour of the madder, is required to produce a like effect on the Brazil-wood. More colour is extracted from this wood by alcohol than by water. Warm marble stained by the spirituous tincture assumes a purplish red colour, which, on the heat being increased, changes to a violet hue. If the stained marble be covered with wax and considerably heated, the colour changes through all the shades of brown, and at last becomes fixed of a chocolate hue.

A fine crimson red lake is prepared from this colouring matter by precipitating it when in a state of solution with alum. The average annual quantity imported for the last five years is 950 tons. Its price has very much fallen off, differing from £65, in 1826, to £35 per ton in 1830. A duty of £2 per ton is charged on the importation of Brazil-wood.

A species of this tree grows in the West Indies, the wood of which is known in commerce as Brazilletto. It is of the same kind, but of very inferior quality to the Brazil wood. The duty charged on its importation from British possessions is only 3*s.* per ton, and in consequence it can be obtained on much cheaper terms than that from South America. Some years ago the demand for it was so great that it was cut down with unsparing hand, and scarcely any of the large trees were left in the British plantations. This species is known to botanists as *cæsalpinia vesicaria;* it never attains to so large a growth as the *cæsalpinia crista.* Its branches are slender and full of small prickles; the flowers are white, growing in a pyramidal spike at the end of a long slender stalk.

Sapan-wood is another dyeing substance obtained from another species of the same genus. It is distinguished as *cæsalpinia sapan.* The flowers of this and the *vesicaria* have ten stamina; those of the *crista* have only five. There is scarcely any consumption of this wood in England; very few tons being annually imported. Its price averages from ten to sixteen pounds per ton, and it is admitted on a duty of fifteen shillings per ton.

The same duty is charged upon Nicaragua or Peach wood, which is another kind of Brazil-wood. It dyes a bright fugitive red, called fancy red. Though not so rich in colouring matter as the Brazil, it yields a colour which is brighter, more delicate, and more beautiful.

It takes its name from the Gulf of Niacaragua in America, opposite to Providence island, whence it was first imported into England. Dampier says this was the only place on the Atlantic where he saw the tree; but that on the South-sea side of the American continent it grew abundantly. In his time Nicaragua-wood was sold at £30 per ton, being double the price of Logwood.

The average importation for the last five years is much more considerable than that of Brazil-wood, being 1765 tons. The price of the best is about £15.

Cam-wood is another red dye-wood, obtained from the Brazils, and also from Africa. It once grew commonly in the neighbourhood of Sierra Leone, and was found at Tonquin and other parts of Asia. This wood is of a very fine colour; it is principally used in turnery for the formation of handles of knives and other similar articles. A very small quantity of Cam-wood is imported into this country, averaging annually not more than 400 tons. It is admitted at the same duty as the sapan. Bar-wood is also liable to the same duty, and is not brought more abundantly into England. This is likewise a red dye-wood of Africa.

Indigo *(Indigofera)*. Natural family *leguminosæ; diadelphia, decandria,* of Linnæus. There are not less than twenty-four species of this genus enumerated, all natives of tropical climates. In Hindostan, China, Japan, the southern parts of Africa, America, Java, and Madagascar, the various species of this plant grow in a wild state. The three species chiefly cultivated for the production of the blue dye, are the East Indian *(Indigofera tinctoria);* the West Indian *(i. anil);* and the Silver-leaved *(i. argentea).* The East Indian, which is that most largely cultivated, is not so hardy, nor is its pulp so good as the others; but it yields a larger produce, and on this account is preferred.

The West Indian plant grows much higher, and is hardier than the *tinctoria,* while the silver-leaved or wild indigo, is hardier than either of the other two, and yields the finest pulp, though in least quantity. They are all rather elegant little shrubs, and all yield more or less indigo.

The East Indian plant *(ind. tinctoria)* has a

root of about a quarter of an inch in thickness, and upwards of a foot in length. The root has

190.

Indigo.

a faint smell, somewhat resembling parsley. From this root issues a short bushy stem of nearly the same thickness; this stem rises about two feet from the ground; it is hard and almost entirely ligneous, and without any appearance of pith in the inside. The leaves are winged, or consist of small leaves ranged in two or three pairs on each side of a long foot-stalk, which is surmounted by an odd leaf; they are of an oval form, smooth and soft to the touch, furrowed above, and of a darker colour on the upper than the under side. From about one-third of the stem to the extremity, there are ears that are loaded with very small flowers, from twelve to fifteen in number; these are destitute of smell; they are succeeded by long crooked brown pods, which contain small yellow seeds. The wild indigo has shorter pods and black seeds. The seeds of the Guatimala are green, and the stalks red. This plant requires a smooth rich soil, well tilled, and neither too dry nor too moist. Indigo is entirely the production of a warm climate; it has been observed that it is "the child of the sun," and cannot be advantageously cultivated any where except within the tropics. A higher temperature than 60° is absolutely necessary both for its vegetation and maceration.

The seed is sowed in little furrows about the breadth of the hoe, and two or three inches in depth. These furrows are made a foot apart from each other, and in as straight a line as possible. A bushel of seed is sufficient for five acres of land. Though it may be sown in all seasons, spring is mostly preferred for the purpose. Soon after sowing, continual attention is required to pluck the weeds, which would quickly choke up the plant, and impede its growth. Sufficient moisture causes it to shoot above the surface in three or four days, and it is usually fit for gathering at the end of two months. When it begins to flower, it is cut with a sickle a few inches above its roots. The ratoons, or subsequent growth from the same plant, ripen in six or eight weeks. Sometimes four crops are obtained in one year from the same roots; but in North America and other parts where the sun is less fervid, the cultivator obtains but two, or perhaps only one crop. The produce diminishes fast after the second cutting, and therefore it is said to be absolutely necessary to sow the seeds afresh every year, or every two years at farthest.

The Arabs in Egypt however sow the seed of this plant only once in seven years, and obtain two crops in a year. The sun which so rapidly improves and invigorates the plant, propagates at the same time an insect destructive to it. This is a species of grub or worm, which, becoming a fly, preys on the leaves and too often disappoints the planter's expectations, especially when the plant is grown a second year upon the same land. The only known remedy is to change the soil every year. This plant has not only to contend against the vicissitudes of the seasons and the ravages of the insect peculiar to it, but the leaves, which are its most valuable part, are liable to the depredations of caterpillars, myriads of which sometimes attack a plantation, and devour all the leaves in the short space of twenty-four hours.

The real nature of indigo was not generally known in Europe until a long period after it had been obtained direct from India, the country of its production, and many erroneous notions existed as to its nature at a comparatively recent period. In the letters patent granted to the proprietors of mines in the principality of Halberstadt, not many centuries ago, indigo was classed among the minerals, to obtain which the works were permitted to be erected.

Marco Polo, indeed, who flourished in the thirteenth century, and who is the earliest European traveller into China and India on record, relates that he saw indigo made in the kingdom of Coulan, and describes the process by which it was prepared. "Indigo," says the old Venetian, "of excellent quality and large quantities, is made here (Coulan). They procure it from an herbaceous plant, which is taken up by the roots and put into tubs of water, where it is suffered to remain till it rots, when they press out the juice. This, upon being exposed to the sun, and evaporated, leaves a kind of paste, which is cut into small pieces of the form in which we see it brought to us." This passage of the Italian ought at least to have prevented the Germans from considering the product as a mineral which they were to seek in the bowels of the earth; but illiberal ignorance had thrown discredit on Marco Polo, and ranked him among those travellers whose lies were proverbial. At two other places in India, Guzzerat and Kambaia, Marco speaks of indigo as an article of extensive manufacture. Much curious information in regard to the trade in this article at the middle of the fourteenth century, is contained in the works of Francesco Balducci Pegolotti. At that time indigo was imported in leather bags and in chests in the

same manner as at present. Although for more than two thousand years its value had been recognised in Asia, still its use was either prohibited or restrained for a considerable period in different European countries, under the erroneous belief that its colour was fugitive.

About the sixteenth century improvements in the art of dyeing were attempted in several European countries. Among the many new methods employed, some gave greater brilliancy, others greater permanency to the colours. Some, however, though they might impose on the eye, gave but an evanescent beauty of tint; while others subjected the stuffs to pernicious chemical preparations, whereby their texture was injured, and they were found "to rot on the shelves of the shop-keeper." Governments were in consequence induced to interfere by legislative enactments, to prevent their subjects from being imposed upon by "these false and pernicious dyes;" and prohibited at once the use of all the new materials which produced only fleeting shades, and which contained, or were supposed to contain, any thing detrimental to the stuff under preparation. Now, these governments, to their mistaken views of domestic policy, united an equally profound ignorance of chemistry; and listening to the reports of the uninformed or interested, sometimes laid under one prohibitory ban the useful as well as the hurtful. In Germany a decree of the diet, held in 1577, prohibited under the severest penalties "the newly invented, pernicious, deceitful, eating, and corrosive dye, called the *devil's dye*, for which vitriol and other eating substances were used instead of woad."

In the middle of the next century, the use of indigo was found to interfere with the cultivation and sale of woad, which had hitherto formed a considerable branch of industry with the Germans. A prohibition was therefore issued against its use in Saxony, and in order to raise a prejudice against it in the minds of the people, and that they might be blinded by the imposition of a name, it was classed among those substances already prohibited as *devil's dyes*, and this prohibition was for some years enforced with great vigilance and severity. The people of Nuremberg, who at that time cultivated woad, went still farther. They made a law that their dyers should annually take an oath not to use indigo. Although the dyers do not scruple to avail themselves in the present day of the superiority of this colouring matter, the oath is still enforced; and this strange unrepealed edict may be classed among those demoralizing relics of defective government which take from an oath its sanctity, and prepare the minds of the people to dread the penalty, rather than to abhor the crime of perjury. The use of indigo was likewise forbidden in France from 1598 to 1669, when Colbert showed more enlightened views on the subject, and the prohibition was repealed.

It was not until after the discovery of America that indigo was obtained in any very large quantities in Europe. The plant from which it is prepared was found growing wild in most of the tropical parts of the western hemisphere. Its application was likewise well known. We learn from the authority of more than one traveller, that the Aztecs, the unfortunate aborigines of Mexico, were well aware of its value as a dye, and that it was commonly employed by them in giving a beautiful hue to their cotton fabrics. During the last century the cultivation of indigo has been almost entirely neglected by the Spanish Mexicans, from the preference given in Europe to the indigo of Guatimala, or central America, and the failure of the native cotton manufacture, in which it was principally used. Since the Mexicans have shaken off the Spanish yoke, their commercial and agricultural prosperity has become a subject of more rational interest and attention. Attempts are now therefore being made to revive, among other branches of industry, the cultivation of indigo. A little is now grown on the western coasts, and it has been introduced into the valley of Cuautla. In some parts, which are hot and marshy, it is a natural production of the soil.

The indigo of Guatimala was long prized as the best, and although this plant was cultivated in the West Indies and other parts of America, none ever approached to the excellence of that of Guatimala, which was long rated in commerce as of unrivalled quality. This plant was much cultivated in the French West India islands, and the government of the parent country took so great interest in its improvement, as to appoint scientific men to investigate its preparation, and to point out in what manner it was susceptible of improvement. It does not appear, however, that these exertions were attended with any very beneficial results, and although much was suggested, perhaps no real, certainly no very important, improvements were introduced in the mode of preparing indigo. That prepared by the French still ranked lower, though next in quality to the produce of Guatimala.

This plant was for some time cultivated in great abundance in Jamaica, forming one of its principal articles of exportation; but a tax having been laid upon it, the culture of sugar became a more profitable branch of agriculture. *Indigofera* was found growing spontaneously in Carolina in the year 1747, and so abundantly, that 200,000 lbs. were shipped to England, and sold at a very good price, though it was not quite so well prepared as the French indigo; its farther cultivation in North America has not, however, been very extensively prosecuted.

In the year 1787 another source for the supply

of Indigo was opened by the French, who then began to import cotton and indigo from their settlement at Goree, on the coast of Africa. This dye was pronounced by the English dyers to be almost equal to that of Guatimala, and superior to every kind of West India indigo.

England, though now occupying so commanding a position in the commercial and manufacturing world, was for a long time slow not only in originating inventions and improvements, but even in adopting those of other nations. A long period elapsed after the discovery of America, before indigo began to take its rank among the most useful ingredients of the English dye-house. Richard Hakluyt, at the close of the sixteenth century, mentions it as an object deserving of inquiry, as at that time it was not known in this country what plant produced the indigo. Instructions were therefore given to discover whether "*Anile*, that blue colour, be a natural commodity, or, if it be compounded of an herb, to send the seed or root with the order of sowing." The French name of indigo is *anil*; it is known under that term, or simply *nil*, in South America, whence it was adopted by the French and Portuguese. It is remarkable that *Nile* is the Arabic name of the same plant. The name by which it is designated in English is evidently a corruption of the ancient *indicum*, but on its first introduction into England from America, it was usually known as anil. In Chinese it is called *tien haam*, which signifies sky blue.

Indigo from America was for a long period very superior to that obtained from the East; and although this dyeing ingredient was recognised in commerce as coming from the East Indies, it was imported thence in small quantities, and of so indifferent a quality, as not in any way to compete with the western production. Scarcely twenty years ago, this was the relative position of the indigoes from America and Asia. Since then the judicious and spirited exertions of a few enlightened individuals, have shown, that by careful cultivation and preparation, its character might be essentially improved in the British possessions in India. At the present day this article ranks among the most important objects of our commerce with the East Indies, while its quality has been raised far above that received from South America.

Indigo has long been cultivated in Spain, but is on the decline in that country, owing to the more favourable circumstances attending its culture in the East and West Indies. During the reign of Bonaparte, and his attempted restrictions of commerce, it was also tried in the south of France and Italy, but proved a failure.

The colouring matter is obtained from the whole plant. There are two modes used for its extraction—it is fermented, or it is scalded. The first method is universally practised in South America and the West Indies; and almost wholly by the English factors in the East.

In an indigo house, where the fermenting process is pursued, the chief apparatus consists of three wooden vats of different sizes, placed on different levels, so that the contents of the first may flow into the second, and those of the second into the third. The plants, on being cut, are laid in the first or steeping vat, in sufficient quantity to fill it without receiving pressure, and water is poured over them until it rises about three inches above the level of the top plants. A frame of heavy wooden bars is then laid on the vat to prevent the plants from rising when in fermentation. This state is generally induced in less than eighteen hours. The contents swell and foam; large bubbles of gas are formed, which on being disengaged appear of a lively green, and tinge the whole vat of the same colour. When at the highest, the fermenting mass is covered with a brilliant copper-coloured scum, which passes into violet towards the end, but the pulp and liquor remain green. The gas given off during the process is inflammable. The heaving of the scum is so powerful as often to lift up the heavy wooden frame above mentioned. This fermentation is carried on for the purpose of extracting all the grain or colouring matter from the plant, and it is a nice point to ascertain the exact period when it ought to cease. If the fluid be drawn off too soon, much of the pulp is left behind, and if too late, the tender tops of the plant occasion putrefaction, by which all the dye is destroyed. Many plans have been suggested to discover to a scientific certainty the most advantageous degree of fermentation. Experiments were made at St Domingo, when the French possessed that island, under the sanction and encouragement of the Chamber of Agriculture; but the unsatisfactory result only served to convince practical men that they could not with safety trust to any test save that of experience. In order to ascertain the state of fermentation, it was recommended to dip a pen, at intervals of every quarter of an hour, into the contents of the vat, and to make with it a few strokes on paper: when the marks thus made are colourless, it is the proper period for arresting the fermentation. Much practical skill is required in seizing on this moment, in which the fermenting mixture assumes the appearance of a liquor, holding in suspension a distinct green pulp, which by slight agitation speedily and completely separates and falls to the bottom, leaving a clear gold-coloured supernatant fluid. The whole of the turbid green liquor is then discharged from the steeping vat, and passes into the second vessel. The first vat is then immediately cleansed, fresh plants are thrown in, and the work proceeds without intermission. The refuse matter is carefully

removed from the house as soon as taken out. The noxious odour of this refuse occasions the peculiar unhealthiness incident to the occupation.

As soon as the liquor is received into the second vat, it is violently beaten by the repeated fall of wooden buckets, full of holes, and fixed to long handles moved by manual labour or other power. A more complicated mechanical contrivance is sometimes employed. This agitation of the parts, by checking any farther fermentation, prevents putridity, and especially promotes the separation of the grain, as it is technically called, or the dark coloured granular pulp, which is the indigo. The whole of the liquor and of the pulp change during the process from green to deep blue. A large quantity of air-bubbles are also expelled by the beating. Lime-water is most usually added at this time, as it greatly assists in the formation of the grain. When the grain, on being left in a quiescent state for a brief period, separatés readily from the liquor which holds it suspended, the agitation is stopped, and the grain slowly subsides. The same degree of nicety is required to discover the exact point for the cessation of agitation as for determining that of fermentation. If too little beaten, the grain will not be sufficiently separated; if too much, a second fermentation would be excited, which would alter the dye, spoil its colour, and make what is called *burnt indigo.* From time to time, therefore, a little is drawn off and examined.

When the grain is precipitated, the liquor floating on the top is drawn off by means of cocks, and suffered to run to waste; care being taken to avoid mixing it with any brook or cattle pond, as it contains poisonous qualities which would be fatal to animals who might drink it. The thick pulpy matter is then discharged into the third or lowest vat, and after it is still more disencumbered of superfluous water, it is laded into common sacks. These are hung up that the water may drain off, the indigo itself being too thick to pass through. After draining it is transferred to small wooden boxes, where it is farther dried by exposure to alternate sun and shade.

In the indigo factories of Bengal, some part of the moisture is driven off by the direct application of fire heat. This is done after the colouring particles have been separated from the solution by beating. The indigo is then removed from the agitation vat into a boiler, the bottom only of which is of iron, while the sides are built up of solid masonry. Of course only this bottom can be exposed to the action of the fire, by which circumstance the efficiency of the vessel is importantly diminished; fuel is wasted, because that portion of the heated air which should apply to the sides, is prematurely drawn off into the chimney; time is lost, since the fluid will necessarily impart to the masonry a portion of the heat which it is made to imbibe; and, for this last reason, the liability of the indigo to the far greater evil of charring is much augmented. If a better arrangement were provided for this purpose, the process would be materially simplified, and might be carried farther than is now consistent with prudence.

When the indigo is brought by this means to that degree of consistence which is safely practicable, the thickened fecula is transferred to large cloths wherein the evaporation is further continued by exposure to atmospheric influence.

This intermediate operation of boiling is considered to be beneficial in arresting a second fermentation of the fecula, to which it is sometimes liable during the process of draining, while the farther advantage is obtained of holding in solution the gummy and other matter unavoidably extracted with the colouring matter. This extraneous part thus passes off with the water, and leaves the indigo in a purer state. The superior quality of the Bengal indigo is attributed to this method of preparation.

If dried hastily in the sun it is apt to become brittle. When all moisture is expelled, and the substance is quite solid, it is cut into square cakes. The process is not yet, however, completed. If exported in this state it would speedily become mouldy; a second fermentation is therefore necessary. To produce this the cakes are heaped in a cask, and simply suffered to remain there for about three weeks. During this time they undergo a degree of fermentation; they become heated, moisture exudes from the surface, a most disagreeable odour is emitted, and finally the cakes are covered with a fine white meal. They are then taken out and dried in the shade for five or six days, when they are in a fit state to be packed for exportation.

The second method by scalding, instead of fermentation, was first proposed for adoption by Dr Roxburgh, and its great advantages over the usual process were forcibly pointed out. The method of obtaining the colouring matter, however, by boiling the plant was by no means the invention of Dr Roxburgh, although that gentleman has the merit of investigating scientifically the peculiar nature and properties of indigo, and of adopting and recommending a treatment of it in accordance with his more enlightened views on the subject. The Hindoos and the Egyptians both pursue this apparently more simple process.

In Egypt the plants are dried previously to being put into an earthen jar with hot water. They are then worked with a palm branch, in the manner of churning, until the whole of the colour is pressed out. The liquid is next strained

through the bark of a tree into another jar. It is left there for eight or nine days, during which time part of the water escapes by trickling through a small aperture half way down the side of the containing vessel, leaving the sediment at bottom. This residuum is afterwards poured into a broad but very shallow hole formed in the sand, which absorbs the remaining liquid, and leaves the indigo in solid cakes on the surface.

The Hindoo method at Ambore is somewhat similar, though more elaborate. The plants are first boiled in earthen pots of about eighteen inches in diameter, disposed in the ground in excavated ranges, from twenty to thirty feet long, and one broad, according to the number used. When the boiling has extracted all the colouring matter ascertainable by the colour exhibited, the extract is immediately poured into another small jar fixed in the ground for its reception, and it is then filtered through a cloth, and laded by means of small pots into a larger jar disposed in adjoining higher ground. The contents of the larger jar, when three-quarters full, are agitated with a split bamboo extended into a circle, having a diameter from thirteen to twenty inches; this hoop is twisted with a sort of coarse straw, with which the manufacturer proceeds to beat or agitate the extract until a granulation of the fecula takes place. This operation occupies nearly three-quarters of an hour. A precipitant compound of red earth and water,* about four quarts, is poured into the jar. The whole stands during the night; in the morning the supernatant liquor is drawn off through apertures in the side of the jar, the lowest reaching to within five inches of the bottom, thus leaving just sufficient space to retain the fecula, which is taken out and dried in bags.

The method by scalding has only been very partially adopted among the English in the East; the dyers of this country not reporting favourably of indigo thus made. It is said that it contains much less colouring matter than that obtained by fermentation, and that the dye produced is not so permanent.

The indigo factories in the East Indies are conducted very differently from those in the West, on account of the dissimilar circumstances of the population of the two countries. In the West Indies the indigo plantations, and the works connected with its preparation, are all the same property, and under the same superintendence. In Bengal and other of the British possessions in India the cultivation is exclusively left to the Ryots, or native farmers, who are provided with seed by the factor, and bound to deliver at a certain rate of price the whole of the plants produced from these seeds. The cultivators, in consequence of failures in crops, or other accidents, too frequently require advances from their employer; and thus, though nominally free, they are in reality subjected to him, and compelled to raise the indigo exclusively for the supply of his factory. These factories are generally on a very large scale, by which a much greater quantity of colouring matter is produced, than would result if natives were employed in its preparation as well as in its cultivation. It is calculated that in the European method one man can bring to issue one vat, containing fifty bundles of indigo plants, which, according to quality, will afford from ten to thirty pounds of indigo; whereas by the Indian method, one man employed during the same time will produce only one pound of indigo.

The extensive indigo factories are nearly always remote from the seat of the English precedencies. The superintendence of an establishment is seldom intrusted to any but one of its proprietors; who, entirely excluded from the society of his countrymen, consents to many privations, with the hope that in a few years he may reap sufficient wealth to ensure to his future life those enjoyments for whose possession he has been willing to sacrifice, as it were, a part of his existence. As soon as he has accomplished this end, he usually resigns his situation to a junior partner, who pursues the same course.

These expectations are not, however, always fulfilled. The profits of an indigo property are in some seasons greater than those afforded by almost any other investment. One acre of rich land, by proper cultivation and management, may be made to yield annually 500 pounds of indigo, and in some years indigo of the best quality has in England been as high priced as eleven shillings per pound. According to both Edwards and Stedman, 300 pounds are produced on ordinary land, and the labour of four persons is required for the cultivation of five acres, and the subsequent preparation of the produce.

The large returns consequent on favourable crops, and the high prices of the home market for a few successive years, lead to the belief that the profits will always be thus excessive; and although the frequent and disastrous casualties which follow these periods of prosperity, should excite doubts as to the realization of all the extravagant expectations which are so sanguinely indulged, yet the confidence which each person has in his own peculiar "luck," or superior management, too readily induces him to become a participator in the cares and hopes of an indigo factory.

It might be supposed that establishments thus

* This red earth and water debase the indigo. In the northern parts of the coast of Coromandel the natives use a cold infusion of the bark of the jambolong tree *(jambolifera pedunculata)*, which is a very powerful astringent to precipitate their indigo. This indigo is of a very good quality.—*Dr Roxburgh.*

superintended by persons who are deeply interested in their success, would be conducted in the best possible manner; while improvements would be continually suggesting themselves, by which favourable results might be attained with greater certainty. Surprise must therefore be excited when we find that very little scientific knowledge is engaged in the pursuit, and that the whole is arranged and conducted by means at variance with philosophical principles, a due attention to which might often produce totally different results.

Until within the last few years, since the appointment of Lord William Bentinck as governor-general of India, Europeans were not allowed to take the land in their own hands for agricultural purposes, and they were therefore of necessity dependent on native industry for the produce of the soil. The cultivation of indigo was thus left to the care of the indolent and prejudiced Hindoo, who from age to age is found obstinately pursuing the same track, without deviation or improvement, making no attempt to discover the cause, or arrest the progress of those ravages so often fatal to his whole crop, but which the superior intelligence of skilful European agriculturists might perhaps successfully combat.

The uncertainty of this production, though in the present day more known and felt in the East, was equally great in the West Indies during the time when its cultivation formed there an object of importance. In a statement of the comparative advantages of different crops, Mr Edwards, after dwelling on the extreme productiveness of indigo, thus continues: "Unhappily, however, the golden hopes which speculations like these have raised in the minds of thousands have vanished on actual experiment like visions of the morning. I think I have myself, in the course of eighteen years in the West Indies, known at least twenty persons commence indigo planters, not one of whom has left a trace by which I can now point out where his plantation was situated, except perhaps the remains of a ruined cistern covered by weeds and defiled by reptiles. Many of them too were men of knowledge, foresight, and property. That they failed is certain, but of the causes of their failure I confess I can give no satisfactory account. I was told that disappointment trod close at their heels at every step. At one time the fermentation was too long continued, at another the liquor was drawn off too soon. Now the pulp was not duly granulated, and now it was worked too much. To these inconveniences, for which practice would doubtless have found a remedy, were added others of much greater magnitude,—the mortality of the negroes from the vapour of the fermented liquor, the failure of the seasons, and the ravages of the worm. These or some of these evils drove them at length to other pursuits where industry might find a surer recompense."

To this melancholy statement may be added the fact, that of all the productions that have been made objects of great commercial speculation, not one has of late years so tended to swell the sad list of bankruptcy and ruin as indigo.

The prepared indigo of commerce is usually imported in square, or oblong cakes, of an intense blue colour, approaching to black. The specific gravity of the best quality is small. It has a peculiar and disagreeable smell.

There is no article of commerce which fluctuates more in its price, and is of greater variety of quality than indigo. It is distinguished according to its different shades of colour, arising from the manner of its preparation, and the proportion of foreign substances with which it is mixed. The principal shades are blue, violet, and copper colour; the blue being the best quality. These are again subdivided into fine, good, and middling. The indigo which is imported from different countries is known in commerce by its relative value, and accordingly there are no less than twenty-four kinds in the English market, each bearing a different price, varying through all the intermediate proportions from 8*s*. 6*d*. to 2*s*. per lb,; Bengal is the best, and Manilla indigo the worst in quality. In 1831, 7,307,313 lbs. of indigo were imported into England. The duty on that coming from British possessions is 3*d*., on other sorts 4*d*. per lb.

However carefully indigo may be prepared, there are always more or less of impurities mixed up with it. The relative quantity of these is ascertained by the specific gravity of the indigo, which is lighter in proportion to its purity. Bergmann found that the best indigo which he could procure contained more than half of extraneous matter, being in these proportions:—

Pure indigo	47
Gum	12
Resin	6
Earth	22
Oxide of iron	13
	100

Proust, on subjecting indigo to analysis, found it to contain a large proportion of magnesia. This substance has very singular chemical properties. It is now well ascertained to be composed of the fecula of the plants combined with oxygen, to which it has so great an affinity that its transition from green to blue on exposure to the atmosphere is instantaneous. Pure indigo is insoluble in water, alcohol, ether, or oils; neither alkalis nor earths have any action on it, nor have any of the acids hitherto tried, except the nitric and sulphuric. Nitric acid converts its colour into a dirty white, and finally decomposes

it completely. Sulphuric acid dissolves it, and causes it to acquire a more lively, though a less durable colour than it naturally possesses. This peculiarity has been taken advantage of by the dyers, and sulphate of indigo, under the name of Saxon blue, is a well known ingredient of the dye-house. Its application was first discovered and carried on in Saxony in the year 1740, whence its name. That powerful chemical agent, chlorine, instantly decomposes indigo.

This valuable dye has a strong affinity for almost every species of fibrous texture, whether animal or vegetable; it can therefore impart to all descriptions of stuff a very permanent colour, without the assistance of a mordant. By the superiority and richness of its dye, the facility with which it is worked, and the other advantages attending its employment, indigo has nearly superseded the European woad as a first colour; woad being now rarely used except as an auxiliary. Indigo can only be applied as a dye in a state of solution, and must consequently be deprived of its oxygen, to be rendered again soluble in water. Ingredients therefore, having a strong affinity for oxygen, are mixed in the vat together with the indigo, whereby it is again held in a state of solution. To produce this effect, the dyers usually employ protoxide of iron, to deoxidize it, and lime water to render it soluble in its yellow green state. Bancroft considers that its colouring matter is somewhat injured by this process, and supposes that the very durable blue dyes of some nations, in different parts of Asia and Africa, are derived from the indigo plant employed when the colour is first extracted by steeping and fermentation. The Chinese are said thus to apply this dye, and the Africans use it in a way nearly similar. Mr Clarkson has remarked that the dyes of Africa are superior to those of any other part of the globe. The blue produced there is so much more beautiful and permanent than that which is extracted from the same plant in other countries, that many have been led to doubt whether the African cloths brought into this country were dyed with indigo. It was believed that this vivid and permanent African colour, which obtained more lustre by repeated washings, must have been derived from some other plant, or extracted from some of the woods of the country celebrated for imparting beautiful colours. It has, however, been clearly ascertained, that the balls of indigo, prepared by the Africans, are simply the leaves rolled up. Two or three of these balls have been procured, and subjected to chemical examination.

M. Adanson, in noticing the indigo cultivated by the negroes in Senegal, observes that these people do not take much trouble to draw the dye out of the plant. The leaves are gathered at any time in the year, and merely pounded in a mortar till reduced to a paste. This paste is made up into leaves in order to be preserved dry. When required for use it is dissolved in a kind of ley, made of the ashes of an unctuous plant which grows in the fields, and is called by the natives *rhemi*,—in this, the cloth to be dyed is immersed. It is supposed that indigo in this state, will keep as long as that which has received the usual preparation; but the enhanced expense of freight caused by the much greater bulk of the article thus simply prepared, is perhaps a sufficient objection to its importation in that form.

Indigo is imported into England at a duty of threepence per pound for that grown in British possessions; the addition of another penny per pound is placed on that coming from foreign ports.

The average quantity of this substance annually imported, for the last five years, is 27,342 chests of East Indian, weighing from 2 to 3 cwt. each; and 3,151 serons, Spanish, weighing about 250 lbs. each; a considerable portion of which is re-exported to the continent of Europe.

Another species of indigo was discovered by Dr Roxburgh, to which he gave the name of *cærulea*, from the beauty of its colour. It is an erect shrubby species, growing naturally in some parts of India, on dry, barren, uncultivated grounds, to the height of from one to three feet, and still higher in a better soil. It mainly resembles the *indigofera argentea*, somewhat differing from that plant in the shape and growth of its leaves. A much finer indigo of a lighter colour was obtained from it, and in a larger proportion, than from the common plant. Eight pounds of these leaves gave two hundred and forty grains of indigo. Another species of indigo, called by Thunberg the *indigofera arborea*, was cultivated by the Dutch colonists at the Cape of Good Hope.

In the year 1792 Dr Roxburgh transmitted home a sample of indigo prepared from the leaves of a species of rose bay, which he distinguishes by the name of *nerium tinctorium*. From the excellent quality of this indigo, and other advantages attending its cultivation and preparation, it might have been supposed that the *nerium* indigo would quickly have become an article of commerce, and have been in much request among our dye-houses; but it has not yet taken its place among the imported eastern productions, though it should seem that the extensive cultivation of this tree would be attended with much less labour and cost, and offer a greater certainty of profit than the common indigo plant.

The *nerium* grows plentifully throughout the Carnatic, and in every part of the Circars where there are hills and mountains, being an extent of about a thousand miles in length. Near inhabited places it is so often cut down for fire

wood, that in such situations it is always found in the state of a very small tree, or a large bush. But when suffered to reach its full growth, it attains to the height of from eleven to fifteen feet up to the branches. Its trunk, which is of an irregular shape, is about a foot and a half to two feet in diameter. Its bark, when old, is scabrous, but when young smooth and ash-coloured. The wood of this tree is remarkably white and close grained, in appearance resembling ivory. The leaves are oval, pointed, tolerably smooth, and of a pale green colour; they are very numerous, and when full grown, from six to ten inches long, and from three to four inches broad. To cause a greater production of leaves, it should be cut low as the mulberry trees are for feeding silkworms, and like them, the oftener it is cut down the greater is its disposition to increase. Many shoots issue from the old stumps, and in the space of one year these shoots grow to various heights—from one to ten feet, according to the nature of the soil and season. The leaves fall at the commencement, or during the colder part, of the year. In March, or the beginning of April, the young leaves together with the flowers first make their appearance. Towards the end of April, those which were earliest in unfolding attain to their full size. This period was found by Dr Roxburgh to be the most favourable for gathering the leaves; about this time also it ceases flowering, and many of the seed vessels become perfectly formed, though the seeds do not ripen until January or February. The leaves remain in a fit state for gathering until about the end of August, when they begin to acquire a yellow, rusty tinge, and are gradually cast. The colouring matter resides in the leaves alone; all trials to extract any from the twigs proved unsuccessful. Indigo is prepared from these leaves in the same manner as from the indigo plant by the scalding process. The leaves of the *nerium*, unlike those of the common *indigofera*, will not yield their colour to *cold* water, but by *hot* water it is readily extracted. Hard spring water is found preferable in increasing the quantity and improving the quality of the indigo. After being exposed to the action of the fire for about three hours, the leaves begin to assume a yellow hue, then the scalding has been sufficiently pursued, and as the agitation and precipitation do not consume a longer time, the whole process is very speedily completed. From two to three hundred pounds of green leaves yield one pound of indigo.

Mr Marsden, in his valuable history of Sumatra, mentions, that the inhabitants of that island have a kind of indigo which seems to be peculiar to their country. They call it *tarroom akkar*. Totally unlike the common indigo, it is a vine or creeping plant, with leaves four or five inches long, in shape like a laurel, but finer, and of a dark green colour. Its qualities are, however, precisely the same as those of the common indigo; there is no difference in their colours, they are prepared in the same manner, and used indiscriminately, no preference being given to one above the other, except that the akkar, by reason of the superior size of its leaves, yields a greater proportion of sediment.

The people of Sumatra do not manufacture either sort of their indigoes into a solid substance, as is practised elsewhere in the East, and in the West Indies. They merely soak and macerate the stalks and branches for some days in water, then boil it, and work with their hands some quick-lime among it, with leaves of a species of fern, for fixing the colour. They then drain it off and use it in its liquid state.

The Japanese cultivate three other plants—the *polygonum chinense*, *barbatum*, and *aviculare*, for the same purpose, and procure from each of them a beautiful blue colour resembling that from indigo. They dry the leaves, then pound them and mix them up into small balls or cakes, which are sold in the shops ready for use. When they are to be used they boil these cakes in water, adding some ashes to the decoction. This liquid dye is equally available for linen, silk, and cotton.

WOAD *(isatis tinctoria)*. Natural family *crucifera;* class *tetradynamia*, of Linnæus. This

191.

Woad.

plant was at a very early period employed as a colouring matter by the ancient Britons. It was anciently called *glastum* from the celtic word *glas*, blue, whence Glastonbury derived its name. The ancient Britons, when first invaded by the Romans, were in the practice of staining their bodies of a blue colour with some preparation of this substance; thence also is supposed to be derived the name Briton from the celtic *britho*, paint.

This plant was also believed to destroy, by its simple application, all roughness and inequalities of the skin. Pliny, in his description of it, while he notices its use by the dyers, chiefly dwells upon its medicinal qualities. This plant is biennial, having a large woody root, which penetrates deep into the ground. The

stem is from three to four feet high, and about half an inch in diameter, dividing into several branches, which are loaded with many leaves of a lucid green colour, and sitting close to the stalk. They are thick, and of a long oval form, terminating in obtuse points, generally about a foot long, and half a foot broad in their widest part. The branches are surmounted by small yellow flowers, disposed in panicles; these appear in July, and are succeeded by seeds, which come to maturity in September. The soil in which this plant succeeds best is a gentle hazel loam, whose parts will easily separate; that is, a medium between a light, sandy, and a stiff, moist soil. Three or four crops are usually obtained in one year. The first when the stems begin to turn yellow and the flowers are about to appear; the others at successive intervals of six weeks, or more, according to the temperature of the climate. The two first gatherings render the best woad. The plants are mowed down with a scythe, and as soon as collected are washed in a stream of water, and dried in the sun. The desiccation must be rapidly performed; if the season be unfavourable, and the woad be exposed to rain, it will run the hazard of being spoiled. A single night is sometimes sufficient to turn it black. Immediately on being dried from the effects of the washing, it is conveyed to a mill, resembling the oil and tan mills, and is ground into a smooth paste. If this process were deferred for any time it would speedily putrefy, and emit an intolerable and unwholesome odour. This paste is laid in heaps, which are pressed close and smooth, and then covered to protect them from rain. A blackish crust is soon formed on the outside, which, if it happen to crack, is carefully reunited. Should this be neglected, little worms would be produced in the cracks, and the woad lose part of its strength. After remaining thus covered a fortnight, the heaps are opened, and the crust rubbed and mixed with the inside. This matter is then formed into solid balls, which are pressed into a compact substance in wooden moulds. These balls are dried upon hurdles; if exposed to the sun they turn black on the outside, but in a sheltered place they become of a yellowish hue. Dealers in this commodity usually prefer the first, though it is said that there is really no material difference between the two descriptions. Good balls are distinguished by their superior weight, and by exhibiting, on being rubbed, a violet colour within.

These balls require a farther preparation before they can be converted to the purpose of dyeing. They are first beaten with wooden mallets on a brick or stone floor, until they are reduced to a coarse powder. This is heaped up into the middle of the apartment to the height of about four feet, space being left to allow a sufficient passage round the sides; it is then moistened with water, which speedily induces fermentation, and thick fetid fumes are emitted. The heap is daily moistened and stirred about with shovels, for the space of twelve days, after which period it is moved less frequently, and without being watered. At length it is made into a heap for the dyer. Dr Bancroft observes, that the proper mode of conducting the fermentation, and the exact time at which it ought to be stopped, still remain so uncertain, that those who make it their business to prepare woad have no decided facts or indications to govern their management in this respect; and the goodness of any particular quantity can never be ascertained otherwise than by actual use. The powder thus prepared gives only brownish tinctures of different shades, to aqueous, spirituous, or alkaline menstrua; rubbed on paper it communicates a green stain. If the powder be diluted with boiling water and allowed to stand for some hours in a close vessel, then with the addition of about one-twentieth of its weight of newly slacked lime, on exposure to a gentle heat, with frequent stirrings of the fluid, a fresh fermentation takes place, a blue froth rises to the surface, and the liquor, though it appear itself of a reddish colour, dyes woollen of a green colour, which, like that from indigo, changes to a blue, as soon as exposed to the atmosphere. Its nature is very similar to that of indigo in every respect, and experiments have been made which prove the identity of their colouring matter. If the woad plant be prepared like the *indigofera*, indigo will be afforded, though in a much less proportion than that obtained from the exotic plant.

To raise the plants with good large leaves a rich soil is requisite, and a culture nearly similar to that used in raising turnips. The seeds are sown in July, and the plants when they come up are weeded and thinned. Next July, or earlier, the first crop of leaves may be gathered, and two or three others will be obtained during the season. If left beyond two years they will run to seed, and yield but small leaves.

The average produce from an acre of land is about one ton of woad; in very favourable seasons sometimes one and a half ton are obtained. It requires change of soil; the best land is injured by being sown more than twice successively with woad. It is imported into England at rather a heavy impost duty of 3*s*. per cwt., its price being from 18*s*. to 20*s*. the cwt.

Woad affords a substantive blue colour, extremely durable and substantial, which may not only be reduced to many different shades, according to the quantity employed, but is likewise of great use in dyeing and fixing many other colours.

For many centuries it has been an ingredient of great importance with the English dyers. So

early as the year 1198 we find it in very extensive use, and it continued an article of increasing trade until the introduction of indigo, when, as it has been already observed, woad began to decline in consideration. Its natural colour is a deep blue, almost approaching to black. Indigo affords a much more lively and pleasing hue, while it contains, beyond all comparison, a proportionate greater quantity of colouring matter; but it is less permanent than woad, which is therefore still used in conjunction with that and other dyes, but now seldom employed by itself. Its price has been lowered by its lessened consumption, and consequently there is not so much inducement held out for its careful cultivation and preparation. The colour now sold is consequently much inferior to that formerly prepared; and it is supposed that a more careful management might be productive of great improvement in this dye.

Woad is cultivated in the Azores and the Canary islands, in Italy, in Switzerland, and in parts of Germany and of Sweden. It is likewise indigenous to England, and is very extensively grown in Lancashire, where it much used. This plant is also cultivated and prepared in various parts of France. That of the southern departments is the most esteemed, and is distinguished by the name of *pastel.* Another species, the *isatis lusitanica,* is grown in Portugal and Spain. This differs from the *isatis sativa* in being of smaller growth, and having narrower leaves. A species of woad, apparently the same plant as that used by the dyers, is found growing wild in some parts of France, and on the coast of the Baltic sea.

Red Saunders Wood *(pterocarpus santalinus).* Natural family *leguminosæ; diadelphia, decandria,* of Linnæus. This is a large tree, sending off lofty alternate branches, and covered with rough bark resembling that of the common alder. The leaves are alternate, oval, and grouped three together. The flowers are yellow, papilionaceous, and grow in spikes from the axillæ of the branches. This tree is a native of the East Indies, and is found chiefly on the Coromandel coast. Its qualities were first ascertained by König, who sent a specimen and description of it to the younger Linnæus. The wood is solid and compact; on the outside it appears of a dull muddy red, approaching to black; within it is of a brighter red, but becomes brown on exposure to the air. This wood is never employed without being pulverized. It is slow of imparting its colour to water, but yields it readily to alcohol. It does not produce much colouring matter when used alone, but this is a permanent dye. Its colouring matter is found to dissolve much better when mixed with astringent substances, such as walnut-peels, sumach, or nutgalls. With a solution of this in diluted spirit, and on a tin mordant, Volger produced a poppy red; on alum, a scarlet; on sulphate of copper, a crimson; and on sulphate of iron, a deep violet colour.

A very trifling importation of this wood is now received into England. The duty charged upon it is 1s. per ton. Its price varies from £18 to £19 per ton.

The people of Sumatra, who have great skill in extracting and imparting dyes, and who are in possession of a vegetable black dye which is said to be much wanted by us, derive good red colouring matter from several other trees and shrubs.

From the outer parts of the root of a tree, *(morinda citrifolia),* by drying, pounding, and boiling them in water, they procure a red dye, to fix which they employ the ashes yielded by the burning of the stalks of the fruit and midribs of the leaves of the cocoa-nut tree.

Oobar is a red wood which they use in colouring their fishing nets. It resembles the logwood of Honduras, and, in the opinion of Mr Marsden, might be substituted for that product.

Mr Marsden remarks, that the Sumatrans are acquainted with no purple dye, nor apparently are any of the Indian nations, though the art is most ancient among them, and some others of their colours are of unrivalled beauty.

Madder *(rubia tinctorum).* Natural family *rubiaceæ; tetrandria, monogynia,* of Linnæus.

192.

Madder.

This plant is frequently mentioned by the Greek writers, who employed its root as a medicine. The root is perennial, having an annual stalk, and is composed of many long thick succulent fibres, about a quarter of an inch in thickness. It is joined at the top in a head like asparagus, and runs very deep into the ground. Many side roots issue from the upper part or head of the parent root, and they extend just beneath the surface of the ground to a considerable distance. It in consequence propagates itself very rapidly, for these numerous side roots send forth many shoots, which, if carefully separated in the spring soon after they are above ground, become so

many plants. These roots are covered with a black bark or rind; divested of this, they are of a reddish colour, and semi-transparent; a yellowish pith is found in the middle, which is tough, and rather of a bitter taste. The whole has a strong and peculiar smell. From the roots spring forth many large square-jointed stalks; these are weak and unable to sustain their own weight; they rise in good land to the height of eight feet, but if not propped, they creep along the ground. They are armed with short herbaceous prickles, and round each joint are placed in a whorl from four to six spear-shaped leaves of about three inches in length, and in the broadest part almost an inch wide. The upper surface of these is smooth, but the mid-rib on the under side is armed with rough herbaceous pines. The branches which sustain the flowers proceed from the joints; they are placed by pairs opposite to each other, having a few small leaves growing in triplets towards the bottom, and in pairs as they approach the top. These branches are terminated by loose branchy spikes of yellow flowers, the corollas of which are divided into four parts, and resemble stars.

The madder plant does not bear flowers until the second or third year, when they bloom in June, and are succeeded by berries which contain the seeds. It is propagated by shoots. In the beginning of August the land is ploughed in ridges, eighteen inches asunder, and a foot deep; the young plants are placed in these a foot apart from each other. They thus remain for two seasons, care being taken to clear them of weeds. At the latter end of September, when the leaves are fallen off, the roots are taken up and dried for market.

Madder grows best in a moderately rich, light, and somewhat sandy soil. It is a native of the Levant, and grows thus in Italy, in the south of France and Holland, in which latter country it is largely cultivated. Its culture was first introduced into England by Gerard, and subsequently every encouragement for its cultivation in this country was held out; yet although it thrives well with care, it is found that it can be imported better and cheaper from abroad.

According to an experiment made near Tours, an arpent (48,000 square French feet) of ground produced eight thousand pounds weight of fresh roots of madder; but in general not more than four, five, or six thousand pounds are expected from the same space.

As soon as the roots are dug up, they are taken to a place of shelter, so constructed as to admit the air freely from all sides.

The French distinguish two qualities of madder, that which is prepared from the parent root, and that from the side shoots; the first, when the roots are not too large, is considered the best. These two descriptions of root are kept separate in the drying-house, where they are left for four or five days, being turned once or twice during that time, in order that they may dry equably, and that the earth adhering to them may be rubbed off. They are then conveyed to kilns constructed for the purpose, where they are still farther dried. When the roots are sufficiently dried outwardly, they are removed to a floor made as clean as possible, and the outer skin is then separated by means of thrashing.

This skin is pulverized by itself, and packed up in separate casks. It is known in commerce by the name of *mull*, and being extremely inferior to the other part, is sold at a comparatively very low price.

After the outer skin is thus separated, the roots are again conveyed to the kiln, and subjected to a greater degree of heat than before. That this heat may not be injurious to the roots, they are frequently turned, and a current of fresh air is blown through the kiln, to carry off the noxious exhalations of the plant, which would otherwise injure the colour. When the roots are sufficiently dried, they are conveyed to the pounding-house to be reduced to powder.

In warm climates madder is prepared without the application of artificial heat. It results from this difference of preparation, and perhaps also from the variety of the plant, that two kinds of madder are distinguished, which differ in their dyeing properties.

The roots are ground either between millstones or under knives similar to those of a tan-bark-mill. After the first milling, the impurities are separated by means of boulters or fanners. In this state it is so partially cleansed, that the French call it *non-robée*; the residuum consists of earthy matter, epidermis, and bark.

After a second milling, what is separated is called *mi-robée*; and finally, after a third milling, the madder *robée*, or madder cleared from the husk, is obtained, and which is of the best quality. This substance is employed as a red dye, and also as a first tint for several other colours. The madder used for dyeing cotton in the East Indies is in some respects different from that of Europe. On the coast of Coromandel it has the name of *chat*. It grows wild on the coast of Malabar; the cultivated kind is obtained from Vaour and Tuccoun, but the most esteemed is the Persian *chat*, called also *dumas*.

The madder imported in considerable quantities from Smyrna is more esteemed than the best Dutch madder, which ranks the first of that grown in Europe. The madder produced in the lower part of the Rhine is considered by Berthollet as not inferior to that of Zealand.

This is an adjective dye, but affords a permanent colour to cloth which a few days previously has been boiled for two or three hours in a solution of alum and tartar. The colour which

it imparts is not so beautiful as that obtained from kermes or cochineal, but being much less expensive, it is extensively employed for common stuffs. Linen takes this dye with more difficulty than cotton. It is seldom used for silk, but is one of the most valuable dyeing drugs for a variety of purposes. It is an agent for dyeing many colours, and is therefore peculiarly adapted to the process of calico-printing, since by the use of different mordants, a variety of hues may be produced by immersion in the madder bath. One mordant, in combining with it, precipitates the colouring matter red, another purple, another black, and so of every possible shade from lilac to black, and from pink to deep red. If a portion of weld or quercitron be added to the madder, every shade from brown to orange may be produced. Tin, iron, and aluminous bases, as well as other mordants, are used for this purpose, dependent on the colour required. It is a matter of doubt and speculation with chemists whether these various colours are produced by the combination of the colouring principle of madder with the different mordants, by which a chemical change takes place, or whether several colouring matters are not really contained in the substance itself, and severally precipitated or retained by the varying action of the different agents to which it may be subjected. It is, however, certain that it contains at least two distinct colouring matters, a fawn and a red, and that the admixture of the former with the latter very much injures its clearness and beauty. In consequence of this, two kinds of red are obtained from madder. The first is simply called madder red, which contains the whole of the colouring matter. The other possesses far more lustre, and is much more valued; it is called Turkey red, because first obtained from the Levant. Its superior brilliancy is imparted in consequence of the red colouring matter being alone preserved; and while the tint communicated excels in brightness, it has the additional and great advantage of extreme durability.

The manner of producing this desirable effect was for a long period of time a subject of much interest and inquiry, the process used in Turkey being enveloped in mystery. The industry of the French artisans was stimulated by the interest which their government took in the discovery. Yet attempts at imitating this beautiful dye were long fruitless, and when at length they proved successful, this success was limited to one or two dye-houses. It was only by very slow degrees that it came more diffused, and then each individual who acquired the knowledge, jealously guarded his own peculiar secrets which he had introduced in the process.

At length the Abbe Mazeas published the result of his experiments on the subject; and in the year 1765, the French government promulgated all the information which had by its direction been diligently collected. These instructions were entitled, "A memoir containing the process for the incarnate red dye of Adrianople on cotton yarn." Berthellot, Vitalis, and other eminent chemists, have likewise subsequently given an account of the course of procedure. All nearly agree in the detail, whence it appears that the process is most elaborate and tedious. Many different ingredients are used previously to applying the madder. Oil, sheep's dung, calf's blood, gall-nuts, soda, alum, and subsequently a solution of tin are employed, and the yarn undergoes seventeen distinct operations before it is finally imbued with its rich colouring. Many of these materials are considered by Dr Ure as unnecessary, and his opinion has received the confirmation of an eminent calico-printer, who assured him that oil and alumina are the only essential mordants in the process.

It is said that a dilute super-sulphate of potash is now used with success in France for separating the two colouring matters.

It was not until the year 1790 that the art of dyeing the Turkey red was introduced into our country. At that time M. Papillon, a Frenchman, formed an establishment at Glasgow for carrying on the process. He obtained a premium from the commissioners and trustees for manufactures in Scotland, on the condition of communicating his secret to Dr Black, it being stipulated on the Doctor's part that it should not be divulged for a certain term of years, during which period M. Papillon was to have the sole use of, and the benefit accruing from his process. The term being expired, the process pursued was published, and found to be very similar to that already given by the French chemists.

Another species of madder has been cultivated in France by M. D'Ambourney, who found it growing wild among the rocks of Oissel in Normandy. On trial it yielded a dye as beautiful as that of Smyrna madder, and he was therefore induced to prosecute its culture. This plant is rather different from the madder grown in Holland. Its roots are more slender, and of a less bright colour. They are furnished with few fibres at their joints, and those joints are farther apart; the stalk is not so thick, and the leaves are narrower, and of a paler green.

In consequence of the impossibility of drying his roots without fire, M. D'Ambourney was induced to use them fresh after being well washed and cleansed. It is estimated that the root of the madder loses seven-eighths of its weight when dried and reduced to powder. But four pounds of the fresh root were found to be as efficacious as one pound of pulverized madder; therefore, by this plan, twice as much effective colouring matter was obtained: besides which advantage there were many others,—the expense

of erecting sheds and kilns for drying was rendered unnecessary—there was no danger of injuring the substance by improper drying, nor was the cost of a mill for grinding required. Lastly, the roots did not evaporate or ferment, as is the case with powdered madder if not speedily used; but they might be preserved fresh during several months, by laying them in a hole three feet deep, in alternate layers of roots and of earth. Roots are now imported in large quantities into England, and obtain a proportionate higher price than the prepared madder.

In 1804 the gold medal of the society for the Encouragement of Arts, &c., was voted to Sir H. C. Englefield, for his discovery of a pigment prepared from madder. He obtained a fine lake by many different processes, and found that the colour produced from the Smyrna was of a deeper and richer tint than any prepared from the Dutch madder. In pursuing his experiments he discovered that the colouring matter might be extracted from fresh madder, and thus not only all the expenses and difficulty attendant on the process for prepared madder might be avoided, but the cost of carriage would be one-fourth less than for the roots; while separated from these the colouring matter might be kept for any length of time without danger of being spoiled. A further advantage would also arise in the quantity obtained, as *all* the colouring matter could be extracted; while in the manner which the dyers use the roots, a very considerable part of the colour is left in the refuse matter, and consequently wasted.

The following is a slight sketch of the method proposed for obtaining this extract. A given quantity of the roots ground into a pulp is put into a woollen bag. This is then triturated in large vats filled with a certain relative proportion of water; the friction is continued until the colouring matter is entirely washed out of the madder: the water thus loaded with colour is boiled,—an iron vessel must not be used, as a chemical change would take place and the colour would be spoiled. After being boiled it is poured into an earthen receiver, and a solution of alum is mixed with it in given quantities. Then a certain proportion of a saturated solution of mild vegetable alkali is added, which causes effervescence, and the colouring matter is immediately precipitated, from which the supernatant liquor being drawn off, the colour is readily dried for use.

The average annual importation of prepared madder in England for the last five years is 67,525 cwts. Of madder roots 46,272 cwts. The former pays a duty of 2*s*. per cwt.; the latter only 6*d*. for the same quantity. The average price of the best madder for the five preceding years was 83*s*. per cwt., and of the best roots 48*s*. per cwt. It is imported from Holland, France, and Turkey.

An inferior kind of madder, known in commerce under the name of *munject*, is at present imported from the East Indies into this country. The average annual import for the five preceding years is 28,826 bales, each bale weighing 20 lbs.; the average price during that time being 34*s*. per cwt. for the best.

Madder has the singular property of imparting its colour to the animal fluids when given along with food. In this way it tinges the milk, urine, and even the bones, thus affording a proof that the digestive process does not in all cases destroy the natural properties of the substances taken into the stomach.

Its use in medicine is now almost entirely given up. It was supposed to possess diuretic properties, and to be a cure for jaundice.

The Safflower *(carthamus tinctorius)*. Natural family *compositæ; syngenesia, æqualis*, of Linnæus. This plant is a native of Egypt, and the warmer climates of Asia. It is likewise cultivated in the Levant and the southern parts of Europe. The Chinese have long known its use, and produce from it their finest red. The colour called by them *bing*, which is used by the Japanese ladies as a cosmetic, is made from it, and kept in little round porcelain cups. "With this," says Thunberg, "they paint, not their cheeks, as the Europeans do, but their lips. If the paint is very thin, the lips appear red; but if it be laid on thick, they become of violet hue, which is here considered as the greatest beauty.

We obtain it from the East Indies and from Turkey, that from India being considered the most valuable. It is cultivated with success in the gardens of France, but not as an article of commerce. In Spain it is grown in gardens as marygolds are in England, to colour soups, olives, and other dishes. It is also used by the Polish Jews in almost all their dishes.

The *carthamus tinctorius* is an annual plant, with an upright, firm, smooth stem, of a colour approaching to white, and of about three feet in height; this stem is divided at top into several branches, bearing leaves of an oval form, and edged with small spines. Each of the branches is terminated by a large flower head, composed of several flowerets, all of which are furnished with stamina and pistils. The flowers are of a deep red colour. This plant is propagated by seeds, which are sown early in the spring, in drills, at about the distance of two feet and a half asunder.

In about a month the young plants are expected to appear, and they are allowed to remain undisturbed for another month. They are then hoed and thinned, each plant being left about half a foot from the other. A second and third hoeing are given before blossoming. In rich land the flowers seldom appear till late in autumn, while

in a poor dry ground the plants bloom at an earlier period, but the flowers of these are smaller, and yield a less portion of colouring matter. A moderately dry and well manured soil is considered to be on the whole best adapted to the culture of this plant, especially if the seed be sown early in February.

The moment the flowerets which form the compound flowers begin to open, they are gathered in succession without waiting for the whole to expand, since when allowed to remain till fully blown, the beauty of the colour is very much faded. As the flowers are collected they are dried in the shade. This work must be carefully performed, for if gathered in wet weather, or badly dried, the colour will be much deteriorated. These flowers contain two kinds of colouring matter,—the one yellow, which is soluble in water, the other red, which being of a resinous nature, is insoluble in water, but soluble in alkaline carbonates. The first is never converted to any use, as it dyes only dull shades of colour: the other is a beautiful rose-red, capable of dyeing every shade, from the palest rose to a cherry-red. It is therefore requisite, before these flowers can be made available, to separate the valueless from the valuable colour; and since the former only is soluble in water, this operation is matter of little difficulty.

The flowers are tied in a sack and laid in a trough, through which a slender stream of water is constantly flowing; while, still farther to promote the solution of the yellow colouring matter, a man in the trough treads the sack and subjects every part to the action of the water: when this flows without receiving any yellow tinge in its passage, the washing is discontinued, and the safflower, if not wanted for immediate use, is made into cakes, which are known in commerce under the name of stripped safflower. It is principally used for dyeing silk, producing poppy-red, bright orange, cherry, rose, or flesh-colour, according to the alteratives employed in combination. These are alum, potash, tartar, citric acid, or sulphuric acid.

A smaller variety of the *carthamus* is cultivated in Egypt, where it forms a considerable article of commerce. "The dyes the Egyptians use," says Volney, "are probably as old as the time of the Tyrians, and they carry them at this day to a perfection not unworthy that people; but their workmen, jealous of the art, make an impenetrable mystery of the process." Hasselquist, in his Voyage d'Egypte, describes the manner in which the Egyptians prepare the *carthamus* for use. As soon as the flowers are gathered, they are squeezed between two stones to extract all their moisture; they are then washed several times with pit well water, which in Egypt is naturally brackish. On being taken out of the water they are pressed between the hands, and then spread out on mats upon terraces; they are covered during the day lest the drying should be too quickly completed, and they are exposed to the dews of night. Every part is turned over from time to time, and when found to be dried to the proper point, the whole is taken up and preserved for sale.

The colouring matter from the stripped safflower is obtained by the application of an alkaline carbonate. On being soaked in a weak solution of barilla it speedily colours the fluid of a deep red. When the whole of the colouring matter is thus extracted and held in solution by the alkaline menstruum, the infusion is strained. It now remains to precipitate the colour, for which purpose acid is added in sufficient quantity to saturate the alkali employed. Citric acid or fresh lemon juice is generally chosen, because it renders the colour more lively than when in combination with any of the other acids. The carbonic acid gas, which is disengaged during the saturation of the alkali, of course produces considerable effervescence, and therefore care must be taken that the acid be added gradually, and that the dimensions of the vessel are such as to allow of the ebullition without the liquor running over. The colouring matter extracted from the safflower being only kept in solution by the action of the alkali, it is of consequence separated, as this becomes neutralized by the acid, and it fixes on the sides and bottom of the vessel. Most generally, however, carded cotton is introduced into the fluid previously to the application of the acid, and as the colouring matter has more affinity for the cotton than for the surface of the vessel, it fixes upon that as it separates from the alkali. It is scarcely possible wholly to separate the yellow colouring matter in the first washing, and the part which remains renders the shade of colour given to the cotton rather dull, but this is easily removed by repeated washings. If no cotton is employed the precipitate appears in the form of a fine powder. The supernatant liquor is then decanted, the colour washed and distributed upon saucers, where, as it dries, it acquires a coppery tinge; the rose-red colour is produced as soon as this is wetted. The resinous part may also be preserved in a mass by merely drying the precipitate. It is then called India or China lake. It does not communicate any colour to water, but produces a beautiful red tincture when alcohol is poured upon it. This colouring matter, mixed with French chalk, or talc, finely pulverized, is the substance known under the name of vegetable rouge.

To render this substance efficient for dyeing, it must be again held in solution by an alkaline menstruum, in which the stuff to be dyed is immersed, and by the application of the acid the colouring matter is precipitated on the fabric

under process, in a similar manner to that by which it was retained on the carded cotton.

Safflower is imported into England from India and Turkey: the Indian is very much superior, being nearly double the price of the Turkish. It is admitted at the trifling duty of 1*s*. per cwt. The average annual importation for the last five years has been 2,942 bales, each weighing one cwt. The average price of the best during that time was £8 17*s*. per cwt.

In Germany this plant is cultivated pretty extensively on light land well pulverized. It is sown in rows about eighteen inches distance, and afterwards thinned to three or four inches apart in the row. In September the plants begin to flower, and the field is then gone over once a week for six or seven weeks, to gather the expanded florets, which are dried in a kiln in the same manner as true saffron. Turkeys and geese are said to feed greedily on the seed, and soon fatten on it.

St John's Wort *(hypericum perforatum;) polyadelphia, polyandria,* of Linnæus. This plant grows naturally in many parts of Great Britain, and can be easily propagated by layers or seeds. It has a shrubby stalk about two feet high. The branches grow in pairs, shooting forth in opposite directions. The flowers grow at the ends of the stalks, and bloom in July and August. These are succeeded by globular berry-like capsules of a black colour.

The juice expressed from the tops and flowers is perfectly soluble in water, alcohol, and vinegar; a solution in the two former affords a blood-red colour, in the latter a fine bright crimson; when combined with other acids it exhibits a yellow colour, which proves that it contains two colouring matters, capable of separate solution in different menstrua. If alum, combined with a certain portion of potash, be used as a mordant, a bright yellow dye is obtained; by increasing the quantity of the mordant, the colour somewhat inclines to green, and by the addition of a solution of tin in nitro-muriatic acid, according to the proportion used, rose, cherry, or crimson hues, all of a fine lustre, will be produced.

This juice can be made to assume a concrete form by being exposed in shallow dishes to the moderate heat of an oven. If then it be reduced to powder, it will readily combine by trituration with turpentine. The resin, thus saturated with the juice, can be mixed with olive oil, and forms the oil of St John's wort, sometimes used in pharmacy. Incorporated with linseed oil, and with the addition of a small portion of oil of turpentine, a fine red varnish is produced, which may be advantageously employed for coating articles of furniture made of wood.

Officinal Croton *(croton tinctorium.)* Natural family *euphorbiaceæ; monœcia, monandria,* of Linnæus. This plant yields the dye called *turnsole.* It is an annual, producing a round herbaceous branching stalk with many leaves, standing upon long slender footstalks. It seldom exceeds nine inches in height. The flowers are produced in short spikes from the sides of the stalks at the end of the branches. They appear in July or the beginning of August, which is the proper time for collecting them. At this time the peasants assemble from the distance of fifteen or twenty leagues round, and each gathers, on his own account, the flowering tops of the plants. These are immediately bruised in a mill, and the dark green juice is expressed into stone vessels. It is then, without loss of time, poured over pieces of canvas or linen provided for the purpose. These first appear of a lively green, but afterwards change to a red-purple hue. Thus prepared, they are packed and sold by the French under the name of *tournesols en drapeaux.* These shreds are employed to colour several articles in domestic economy. The Dutch buy up large quantities, which are used by them to colour wines and the rinds of cheese.

When infused with distilled water they afford an excellent test. Litmus, well known to chemists as a test for detecting alkalis or acids, is prepared from this plant. The former changes its colour to blue, the latter to red. Persons who formerly prepared the litmus purposely concealed the source whence it was derived, pretending that it was extracted from the *heliotropium tricoccum,* in order to mislead others and restrict the preparation to themselves. It is now, however, well known that croton is the plant from which litmus is obtained.

Alkanet, or Bugloss *(anchusa tinctoria).* Natural family *boraginiæ; pentandria, monogynia,* of Linnæus. This plant is a native of the Levant, and the warmer parts of Europe. France, particularly about Montpelier, produces it in the greatest abundance. Our chief supplies are drawn thence; for though it is raised in England, the roots are much inferior to those of foreign growth. It is a hardy plant, growing with a branchy stem, having oval leaves set alternately on the branches. The flowers come forth from the summit in long spikes, growing grouped together like the tiles of a house. It is propagated by seed, sown in beds either in spring or autumn; when sufficiently advanced the young plants are transplanted at intervals of two feet from each other. The colouring matter is confined to the bark of the roots, and therefore the small roots, having more bark in proportion to their bulk than the large ones, afford the most colour, and are considered the best.

Alkanet root is insoluble in water, an aqueous decoction being of only a dull brownish colour; but this substance imparts a deep red colour to alcohol, oils, wax, and all unctuous substances. In consequence the principal use made of it is

in colouring oils, unguents, and lip-salves. It is also fraudulently used, to give a colour to adulterated wines. Wax tinged with it imparts a flesh-coloured stain when applied to warm marble, which by an infusion in alcohol is stained of a deep red colour.

Its consumption is considerable in this country, in comparison with the apparently trifling uses to which it is applied; 55,374 lbs. were retained for home consumption in 1830. The import duty is 2*s.* per cwt.; its price being about £2 10*s.* per cwt.

WELD, or DYER'S WEED *(reseda luteola).* Natural family *resedaceæ; dodecandria, monogynia,* of Linnæus. This plant is well known throughout Europe. It is cultivated near Paris and other parts of France; it is likewise indigenous to England, and is found growing spontaneously in many parts of the country on uncultivated wastes. It thrives in all our abandoned stone quarries, upon the rejected rubbish of the lime-kiln, and waste places of the roads, apparently a perfectly indigenous plant. Unmindful of frost or of draught, it preserves a degree of verdure when nearly all other vegetation is seared up by these extremes in exposed situations. The wild weld does not, however, abound with as much colouring matter as that which is cultivated, although it grows larger and higher. This plant is therefore cultivated for its colouring produce in several of our counties, especially in Kent, Herefordshire, and about Doncaster in Yorkshire. It is not an object of careful husbandry, as it will grow on the worst soils, without the aid of manure.

Mr Swayne observes that it is one of the first plants which grow on the rubbish thrown out of coal pits. The root and bottom leaves are formed from the fallen seeds before winter; and thus it happens in this, as in many other cases, that the wild plant is biennial, whilst the cultivated plant, growing from seeds sown in the spring, is annual. Linnæus remarked that the nodding spike of flowers follows the course of the sun, even when the sky is obscured; this is the case with this plant, as its spike will be found in the morning pointing east, at noon south, and westward in the evening.

Weld is a biennial plant. Its root consists of only a few ligneous fibres. Radical leaves spring forth from this of about four inches long and half an inch wide, spreading circularly near the ground; they are soft to the touch, and of a lively green colour. In good soils the stem which springs up from amidst these leaves is often branchy and furnished with narrow leaves like the radical ones, but smaller in proportion as they approach the flowers. It attains to the height of about three feet before blooming. The stems are cylindrical, hollow, and furrowed, terminating in long spikes of yellowish green flowers, like those of mignonette; these expand in the months of June or July, and are succeeded by globular fruits of the same colour, terminating in three points, and enclosing small brown spherical seeds, which come to maturity in September.

The more slender the stalk the more it is valued. This plant is commonly sowed with or immediately after barley or oats, no other additional care being required but the application of a bush harrow to cover in the seeds. It makes so little progress during the first year, that the reaping of the grain does it little or no injury. In the ensuing summer it is fit to be pulled. The more careful cultivator, however, devotes a piece of ground solely to its propagation. The seed is then sown in the month of August, in about the proportion of one gallon per acre; at the end of two months it is hoed and thinned, the plants being left about half a foot apart. The hoeing is repeated twice more, and at the end of June in the ensuing year, the flowers appear in full bloom and vigour; in a short time the seeds form, and the stalks then acquire a yellow tinge. This is the most favourable period for gathering; the performance of which, previous to these indications, or some time after they are exhibited, would alike be detrimental to the colour of the dye. At the proper time for pulling the plant the seed is not sufficiently mature for propagation, some plants are therefore reserved for this purpose, and left in the ground until September. The plants, after being gathered, are carefully dried, and then tied up in bundles of from thirty to fifty pounds, and sold to those who prepare the colour from them, or to the dyers who sometimes use them without preparation.

It is generally supposed by the cultivators, that the colouring matter is contained in the whole plant, but some assert that the valuable part resides in the seeds alone, and they therefore consider it a very injudicious practice to reserve the whole plant for sale, as the seeds are much wasted, not only by being shaken while the stalks are formed into bundles, but subsequently in the transport of these from one place to another. Nor is this the only disadvantage; the carriage of so bulky an article very much enhances its cost, while if the seeds alone were an article of commerce, their transport from one place to another would be comparatively trifling. The plants occupying a space of six cubic feet, would not yield more than half a peck of seeds. This simple fact might be ascertained without much difficulty, and if the seeds were found to be really the only useful part, surely the dyer would be loth to encumber himself with the whole plant. It is, however, still put into the dyer's pot, occupying one hundred times more space than the quercitron bark, containing an

equal quantity of similar colouring matter. This is one of the strongest grounds for preference that has been brought forward by Dr Bancroft in favour of that bark.

The beauty of the weld colour, however, notwithstanding the great bulk of the article, as compared with other dyes, causes it to be much used by dyers, calico-printers, colour-makers, and paper-hanging manufacturers. It is an adjective colour, but tolerably permanent when used with alum and tartar as a mordant.

In the year 1773, the sum of two thousand pounds was granted by act of parliament to a Dr Williams, as a reward for his discovery of a fast green and yellow dye on cotton yarn and thread. This supposed fast colour was given by the combination of weld with a certain mordant, the composition of which the patentee was permitted to conceal, that foreigners might not enjoy the benefit of his discovery; while he, on his part, engaged to supply the cotton and thread dyers with his dye at a certain fixed price. The mordant used was supposed by chemists to be a solution of tin alone, or of tin and bismuth, which gives to weld yellow the power of resisting the action of acids and of boiling soap-suds, though it is not proof against the continued action of the sun and air. This defect, however, was not easily discoverable, in consequence of the ingenious method which, according to Dr Bancroft, the inventor employed to obtain a favourable testimony of the dyers on the subject. He caused his specimens of dyed yarn to be woven into pocket-handkerchiefs, and gave them to be worn in the pockets of those who were afterwards to attest to the goodness of his dye; and as handkerchiefs enclosed in pockets are not exposed to the sun and air, this want of permanency of colour was not discovered until some time after the reward had been paid, for an invention which proved of little or no value.

A water-colour, called weld yellow, is much used in paper-hanging manufactories. This pigment, as it is usually prepared in London for sale, is the extract of the plant, and is in the form of hard lumps, which must be ground into powder previously to being used. Every colour is in some degree injured by that operation. Messrs. Collard and Fraser, therefore, use a process by which the necessity for subsequent grinding is avoided, the colour being obtained in the form of a fine powder. To produce this desirable result equal quantities in weight of carbonate of lime and soft water are put into a copper vessel; the mixture is raised to the boiling point, and stirred until it becomes of a uniform consistence. Then, to each pound of carbonate of lime, three ounces of pulverized alum are added; this is gradually mixed in, and as carbonic acid gas is by this means disengaged, the operation must be carefully performed, lest the effervescence which takes place should cause the mixture to overflow from the boiler. When the effervescence has subsided, this part of the process is completed, the fire is withdrawn, and the mixture may remain any length of time without injury. Meanwhile the weld plants are placed with their roots uppermost in another copper vessel, into which soft water is poured in just sufficient quantity to cover every part containing seed. These plants, after being boiled for a quarter of an hour, are removed to a tub, where they remain until the liquor is drained from them; the water in which they have been boiled, added to these drainings, are then passed through a flannel filter, to intercept the seeds and fecula. The quantity of plants required for a given quantity of carbonate of lime cannot possibly be ascertained with accuracy, for some bundles contain three times as much colouring matter as others; but should too much of either mixture have been prepared, it can be kept in earthen vessels for many weeks without being in any way deteriorated.

When the weld liquor has been thus prepared, a fire is again kindled under the boiler containing the basis to which the weld liquor is added. The proper degree of colour required can only be obtained by trial. When the mixture is found to have a due proportion of each, it is raised to a boiling heat, and the process is completed. The contents of the vessel are then put into an earthen receptacle, and the colour precipitates in the form of a powder. The next day the supernatant liquor is drawn off, and the residuum placed on large pieces of chalk, which in a few hours absorb the moisture, leaving the colour dry and fit for use. The liquor poured off from the colour is, with the addition of water, used again; the old plants are likewise boiled a second time previously to the addition of fresh ones, so that no colouring matter is lost. Iron vessels must not on any account be used in this process; for the gallic acid, which is very abundant in weld, would instantly dissolve the iron, and "the smallest particle of that metal is fatal to the delicacy of the weld yellow.

Although cultivated in the parts of England we have mentioned, a sufficient quantity of weld is not produced for our home consumption, and we consequently draw it from foreign markets. Some writers have recommended the extension of its cultivation, and argued that it would thrive and render a handsome profit on some of our poorest lands, which for any other purpose are not worth ten shillings per acre. Marshal, in his Rural Economy of Norfolk, says, it prefers a good soil, but others assert that it becomes stalky in a rich soil; and the author of the Journal of a Naturalist, supports the opinion that very poor land is the best for the purpose. "With us," he says, "it grows luxuriantly (*i. e.*

in its wild state), three or four feet high, on a thin, stony, undressed soil, *apparently the very station it prefers.*

THE QUERCITRON OAK BARK, though long in common use in those countries where it is indigenous, was not introduced into England until the year 1785, when Dr Bancroft first applied it to the purpose of dyeing, and obtained a patent for its exclusive use. The *quercus tinctoria,* which produces this dyeing substance, has already been described in the account of timber trees. The quantity of colouring matter contained in this bark is very great, compared to its weight; while the beauty of the colour it imparts is nearly equal to that of weld, and its durability is superior. According to Dr Bancroft, it is capable alone of producing more cheaply all, or very nearly all, the effects of every other yellow dyeing drug. Its value is now fully appreciated, and a large quantity is annually imported from America into this country.

The epidermis, or exterior blackish coat of this bark, affords a yellow colour, but less pure than the other parts of the bark; it is therefore separated from these, being shaven off with a sharp instrument. The cellular and cortical parts which remain are then ground in a mill, some falling into a light fine powder, and the rest into stringy filaments; this last yields only half as much colouring matter as the powder. These are seldom separated from each other, however, but are used together as a dyeing substance. In this state the bark yields as much colour as about eight or ten times its weight, and one hundred times its bulk of the weld plant. The colouring matter is readily extracted by water, at a temperature of 100° Fahrenheit. This decoction is of a brownish yellow colour, which alkalis deepen and acids brighten. All the different shades of yellow may be produced by varying the quantity of colouring matter. It is an adjective colour; the mordants used are nitro-muriate of tin and acetate of alumina. Drab colours are obtained from the same dye, with a mordant of sulphate of iron and carbonate of lime, and olive shades by a mordant of sulphate of copper and carbonate of lime. An extract may be made from the bark amounting to about one-twelfth of its weight, but its colour becomes injured by the application of boiling heat, and therefore the extract cannot be used with advantage in dyeing. It would indeed be a most valuable desideratum if the colouring matter obtained from distant countries could be brought in the form of extract, thus concentrating all their virtues within the least possible space. But hitherto all colours are found to be injured while undergoing this process. The chemist would render an acceptable service to the arts who should discover means whereby this purpose might be successfully accomplished.

Quercitron bark is imported into England under an impost of 8*d.* per cwt.: its price is about 9*s.* per cwt.

The average annual importation for the last five years is 2,214 casks, containing ten cwt. each.

FUSTIC *(morus tinctoria).* Natural family *urticeæ; monœcia, tetrandria,* of Linnæus. This tree is a native of Brazil and of several of the West India islands. It is tall and branching, with a fine head, smooth leaves, and oval-shaped, solitary spines. The whole plant abounds in a slightly glutinous milk, of a yellow sulphureous colour. The berries are sweet and wholesome, and fed on by birds.

The precise period of its introduction into Europe as a dyeing substance is not exactly known, but it was certainly soon after the middle of the seventeenth century, as at about that time we find it noticed among the dyeing drugs in use. It is now in very extensive demand in our dyehouses under the name of *fustic.*

This wood, which is of a sulphur colour, with orange veins, abounds with colouring matter; it may be used substantively, and is tolerably durable, but it can be made extremely so when in combination with the same mordants as are employed with weld or quercitron. Though a permanent dye, it is seldom used for pure yellow, as the colour which it imparts is dull and muddy; it is therefore chiefly employed in compound colours. It goes much farther than weld, but is not of so economical a use as quercitron. In equal weights, quercitron yields four times as much colouring matter as fustic, and their relative prices render the bark a cheaper dyeing material. This wood is, however, found more efficient in some mixtures of colours. It is much employed in combination with indigo, to dye what is called Saxon green. With an iron basis it dyes drab, and with an aluminous basis olive colours. This colouring matter is never applied to calico-printing, since the English dyers have hitherto been unsuccessful in producing from it any thing like an equal degree of clearness or brightness with that of weld or quercitron. Chaptal gives a simple method of obtaining a more lively colour from fustic. It consists in merely boiling in a decoction of this wood shavings of skin, glue, or other animal matter. The stuffs dyed in this preparation will, according to that eminent chemist, take a beautiful and most intense colour.

Fustic is imported into England in large quantities, chiefly from Cuba and Jamaica. That from Cuba is very superior, and usually obtains fifty per cent. higher price than that from Jamaica. It is admitted into England at the nominal duty of three shillings per ton from British possessions, and of four shillings and sixpence from other countries. The average

annual import for the last five years was 6,104 tons. The average price of the best is from £7 to £14 per ton.

Venetian Sumach *(rhus cotinus)*, is a shrub growing principally in Italy and the south of France. Both the root and the stem, when deprived of the bark and chipped, are employed for dying a full high yellow, approaching to orange, upon wool or cloth prepared with nitro-muriate of tin. But the colour obtained in this manner is extremely fugitive, neither is it so bright as the yellow, which can be more cheaply obtained from quercitron bark. Four pounds of this chipped wood affords no more colouring matter than one pound of quercitron. This dyewood is seldom used alone; it is employed merely as an accessary colour to heighten cochineal and other dyes, and to give them an approach to a yellow tinge.

Venetian sumach was long distinguished in France by the name of *fustet*, and, with the wood, the name somewhat altered into *fustic*, was introduced into England. The wood of the *morus tinctoria* was subsequently brought from America, and likewise employed for dyeing yellow; destitute of a name, the American wood also acquired that of fustic, as being like it a yellow dye-wood. A confusion having consequently arisen to distinguish them, the wood of the shrub was called *young* fustic, and that of the large American tree, which is always imported in the form of large blocks or logs, *old* fustic. Many persons have in consequence been misled, so far as to conclude that two very distinct dyeing drugs were the same, differing with each other only in point of age.

The wood known in England by the name of green ebony possesses a species of colouring matter very similar to that of *morus tinctoria*, and is sometimes employed in its stead in dyeing.

Arnatto. *Bixa orellana ; Polyandria, monogynia*, of Linnæus. This small tree is a native

193.

Arnatto.

of South America. The Europeans who first visited America found that the berries which it yields were used by some of the Indian tribes to paint their bodies. The brilliant and showy colour soon attracted the attention of the settlers, who not only applied it to their own uses, but likewise converted it very speedily into an article of commerce. The arnatto tree is also extremely common in Jamaica and other parts of the West Indies. It abounds in Java and Sumatra, and is much valued by the natives of those islands on account of its colouring matter, which they skilfully extract. It seldom attains to more than twelve feet in height. The leaves are of a deeper green on one side than on the other, and are divided by fibres of a reddish brown colour ; they are four inches long, broad at the base, and tend to a sharp point. The stem has likewise fibres, which in Jamaica are converted into serviceable ropes. The tree produces oblong bristled pods, somewhat resembling those of a chestnut. These are at first of a beautiful rose-colour, but as they ripen change to a dark brown, and bursting open display a splendid crimson farina or pulp, in which are contained thirty or forty seeds, in shape similar to raisin stones. As soon as they have arrived at maturity, these pods are gathered, divested of their husks, and bruised. Their pulpy substance, which seems to be the only part that constitutes the dye, is then put into a cistern with just enough water to cover it, and in this situation it remains for seven or eight days, or until the liquor begins to ferment ; sometimes, indeed, weeks or even months elapse before this effect is produced. It is then strongly agitated with wooden paddles and beaters to promote the separation of the pulp from the seeds ; this operation is continued until these have no longer any colouring matter adhering to them. The turbid liquor is then passed through close cane sieves, leaving the refuse seeds behind. The mixture is now very thick, of a deep red colour, and of an extremely unpleasant odour. On being boiled the colouring matter is thrown up to the surface in the form of scum, or otherwise the colour is allowed to subside ; in either case the scum or the precipitate must be boiled in coppers until reduced to a consistent paste. It is then suffered to cool, and made up into cakes, which are dried in the shade. The liquor from which the colouring matter has been removed, is preserved under banana leaves until it becomes heated by fermentation ; it is then re-boiled, and the scum which rises is taken off. It then again undergoes similar treatment, until no more colour remains to be extracted. Instead of this tedious process, which occasions diseases by the putrefaction induced, and which at best affords only a spoiled product, M. Leblond proposes simply to wash the seeds of arnatto until entirely deprived of their colour, which lies wholly in the pulpy part, and to precipitate the colour by

means of vinegar or lemon-juice, and then to boil in the ordinary manner.

The experiments of M. Vauquelin made on some arnatto berries imported by M. Leblond, confirmed the efficacy of the process which he proposed, and the dyers ascertained that arnatto obtained in this manner had at least four times the value of that which was procured in the ordinary manner. It was reported to be more easy to work, to require the addition of less solvent material, to give less trouble in the dyeing vessel, and to furnish a purer colour. Guiliche recommends that the application of heat should be avoided in the preparation of arnatto. There can indeed be no question that this substance is very much injured in its preparation ; as all vegetable extracts, when exposed to the direct action of fire, have their properties lessened, or even altered, by partial charring; an accident which never fails to occur in a greater or less degree. In the country of its production, we are told that this colouring matter is much superior when used, as by the aborigines, fresh from the trees. The Brazilians, by another method of preparation, produce a permanent crimson colour from arnatto. The Spanish Americans mix the berries after having undergone a particular process with their chocolate, to which, in their opinion, it not only gives an excellent tint, but imparts valuable medicinal virtues.

The arnatto of commerce is moderately hard, of a brown colour on the outside, and a dull red within. It is seldom employed in England but as a dye for silken stuffs, or as an auxiliary in giving a deeper shade to the simple yellows. Its colour is a bright orange, but this is extremely fugitive, fading very fast on exposure to the air. It, however, powerfully resists soap, and the action of the strongest acids. Dr Bancroft, in making experiments on this substance, found that pieces of linen and cotton dyed in the usual way with arnatto, and subjected to the action of chlorine, not only retain their colour, but, on the contrary, bore exposure to the atmosphere longer than those pieces similarly dyed, which had not been so treated. Arnatto is acted upon with great difficulty by water, to which it imparts only a pale brown tinge. When made into a dye-bath, alkali is therefore always added, which facilitates its solution, and produces a better colour. The liquid sold in the shops under the name of "Scott's Nankin dye," is nothing but a solution of arnatto in potash and water. Arnatto is perfectly soluble in alcohol; it is much used in this state for lacquering, and for communicating an orange tint to the yellow varnishes.

It is likewise employed in large quantities as a colouring ingredient for cheese, to which it gives the required tinge, without imparting any unpleasant flavour or unwholesome quality.

Arnatto is imported into this country in cakes of two or three pounds weight, wrapped up in large flag leaves, and packed in casks. In this form it is a kind of paste, the evaporation not having been carried on to absolute dryness. Another kind, the roll arnatto of commerce, is of a much superior quality, being a hard extract, and containing a much greater proportion of colouring matter.

The average annual importation for the five preceding years, was 1074 casks, each weighing from three to four and a half cwt.

TURMERIC. *(Curcuma longa.)* Natural family *scitamineæ; monandria, monogynia,* of Linnæus.

194.

Turmeric.

This plant is indigenous to the East Indies, and other parts of Asia, and to Madagascar. It has likewise been cultivated with some success in Tobago; samples of turmeric sent to England from that island having been found superior to that usually imported. It does not, however, yet form an article of importation from the West Indies. Our supplies are brought from the East Indies, China, and Java; of these the Chinese turmeric is the best. The island of Sumatra might also furnish supplies, for it is much cultivated there, and principally used by the natives to give that yellow tinge to their rice, and other food, of which all eastern people seem so fond. The East Indians make the same use of it.

The roots of the *curcuma longa* spread far under the surface of the ground ; they are long and succulent, and about half an inch in thickness, having many circular knots, from which arise four or five spear-shaped leaves, standing upon long foot-stalks. The flowers grow in loose scaly spikes, surmounting the foot-stalks which spring from the larger knots of the roots, and attain to about a foot in height. The flowers are of a yellowish red colour, shaped somewhat like those of Indian reed.

These roots are externally of a colour inclining to grey, but internally of a deep lively yellow. They are very hard, and not unlike, either in figure or size, to ginger. The roots are reduced to powder previously to being employed as a

dye. Turmeric is very rich in colour, but it possesses no durability, nor can any combination of mordants give to it this quality in a sufficient degree. Chloride of sodium and muriate of ammonia are the substances which best fix the colour, but they spoil its beauty by deepening its hue almost to brown. It is sometimes employed to impart a golden cast to yellow made from weld, or to give an orange tinge to scarlet; but the shade which it imparts is very evanescent, and soon vanishes on exposure to the air.

This root was at one time much employed in medicine, chiefly for obstructions of the bowels and liver. It has now entirely fallen into disuse.

It readily gives out its active matter both to water and spirits. In distillation with water, it yields a small quantity of a gold coloured essential oil, of a moderately strong smell, and pungent taste.

In Europe it is sometimes employed as a substitute for saffron to heighten the colour of certain culinary preparations. It is very often used as an ingredient in yellow varnishes.

Sixteen thousand and sixteen bags of turmeric were imported into England in 1830, each bag weighing from one to two cwt.

That received from our own possessions is subjected to an import duty of 2s. 4d. per cwt.; coming from foreign countries the duty is quadrupled. The price of Bengal turmeric is from 22s. to 24s. per cwt., and of the best Chinese 32s. per cwt.

French or Avignon Berries are known in commerce as a yellow dye. They are the unripe berries of a species of buckthorn, the *rhamnus infectorius*, which is an evergreen shrub, a native of Spain and southern France. It grows to the height of ten or twelve feet, sending forth many branches from the bottom.

A particular variety of this plant grows in Candia and other parts of the Levant, yielding berries larger than those which are brought from the south of France. They are distinguished by the name of Turkey berries, and are preferred to the French. Both kinds yield a very beautiful, but remarkably fugitive colour. No mordant has yet been discovered with sufficient affinity to this colouring matter, to render their combination permanent. It therefore cannot be used with advantage to the consumer, except where a fine but very transient colour is required. These berries are, however, of very common use in our dye-houses.

Three thousand four hundred and twenty-five cwts. were imported in 1831. They are admitted on a duty of 2s. per cwt. Their average price for the last five years was 68s.

Yellow berries of another description are brought from Persia, and from some parts of Asia Minor; these are much superior to the French berries. They are very soluble in salt water. A gentleman on a passage from Smyrna, on board a ship that carried a few bags of these yellow berries, observed, that when a leak was sprung, and the pumps applied, the water brought up from the hold was almost immediately of a bright yellow colour. This curious effect, which gave to the deck of the vessel the appearance of a dye-house, continued for two whole days, or until the circumstances of the navigation allowed the sailors to remove that part of the cargo from the action of the sea-water.

The well known pigment, sap-green, is simply the concentrated juice of the ripe berries of buckthorn.

Common Saw-Wort *(serratula tinctoria)*, is a perennial plant indigenous to England, growing in woods and in pasture grounds, where it flowers in month of July.

Dyer's Broom *(genista tinctoria)*. Natural family, *leguminosæ; diadelphia, decandria*, of Linnæus. This plant is a native of Britain, and grows on dry and elevated grounds. It attains the height of about three feet; its shrubby stalks are terminated by spikes of yellow flowers succeeded by pods. The leaves are spear-shaped, and placed alternately on the branches. The colour produced by a decoction of these branches cannot be compared in beauty with that of weld or saw-wort, but it attains sufficient permanency by means of mordants. It is sometimes used for inferior woollen goods in combination with alum or tartar, and sulphate of lime. The Romans employed this plant for dyeing, and it is described by several of their writers. It is still applied to the same purposes in some of the Grecian islands. Tournefort thus describes the process which he witnessed at Samos. "To dye yellow, they throw into boiling water the extremities of the broom; after several boilings, they add a little alum to the decoction. Then they plunge into it linen, woollen, cloth, or leather, or whatever they wish to dye, and removing the cauldron from the fire, leave the material to soak all night. The yellow imparted is tolerably fine, and no doubt more skilful operators might make a more perfect colour of it. This Grecian plant differs from that which grows in the coast of Provence, only in having its leaves narrower and larger." The seeds powdered operate as a mild purgative, and a decoction of the plant is used as a diuretic.

Sumach *(rhus coriaria)*. Natural family, *terebintaceæ; pentandria, trigynia*, of Linnæus. This tree is a native of Syria, and is diligently cultivated in Spain and Portugal, and in some parts of Italy and Sicily. The stems are ligneous, dividing at bottom into many irregular branches, attaining to the height of eight or ten feet. The bark is hairy, and of an herbaceous brown colour. The leaves are winged,

having seven or eight pair of jagged lobes, and terminated by an odd one. They are hairy on their under side, of a yellowish green colour, and placed alternately on the branches. These are surmounted by loose panicles of flowers, which are of a greenish white colour, each panicle being composed of several spikes of flowers, sitting close to the foot-stalks.

The shoots of this tree or shrub are cut down every year close to the root, and after being dried are reduced to powder by means of a mill. An infusion of this yields a fawn colour bordering on green. It is a substantive colour, but may be altered and improved by the judicious application of mordants. The principal use, however, of sumach in dyeing, is the production of black, by means of the large quantity of gallic acid which it affords.

The bark is used instead of that of the oak for tanning leather, and it is said that the Turkey leather is thus prepared. The seeds are used in Aleppo to provoke an appetite before meals. Both leaves and seeds are astringent and tonic.

The different kinds of sumach known in commerce are the Sicily, Malaga, Trieste, and Verona; the first of these being of the best quality. Its import duty is 1s. per cwt.; and its price averages from 12s. to 15s. per cwt. The average annual importation for the five preceding years is 100,101 cwts.

Henna or Egyptian Privet *(Lawsonia inermis)*. This plant is a native of Egypt, and is of easy culture and propagation. It was known to the ancients under the name of *Ciprus*. It is also indigenous to India, Palestine, and Persia. It blossoms from May to August. The leaves are the only parts used. These are gathered, and after being hastily dried and bruised to a pasty consistence, are made to yield, by boiling, the rich colouring matter in which they abound. Sir William Jones mentions that in the island of Hensuin or Johanna, he met with this shrub, not then in blossom. Having heard of the fame of the plant, he, in imitation of the heroes of oriental poesy, had his nails stained with a preparation, and thus obtained sufficient evidence of the durability of the colour; his fingers remaining discoloured until the substance of the nails changed by growth. This plant is much esteemed in the East and in Africa for this strange purpose; and the toilet of the Asiatic or African beauty is deemed incomplete, unless her charms are heightened by this potent auxiliary, the dark tints of which, to European eyes, impart no very becoming lustre. The use of henna is not, however, wholly confined to staining the nails and skin, as it is employed in the East for dyeing ordinary stuffs. It produces a reddish brown substantive dye. There is evidence that the ancient Egyptians made a similar application of this colouring matter, as in the envelopes of their mummies the henna dye is still observable.

CHAP. XLVIII.

MEDICINAL PLANTS—PERUVIAN BARK, QUASSIA, GENTIAN, &c.

From the earliest records of the healing art, it appears that medicinal substances were obtained from the vegetable kingdom. Indeed, almost all medicines were for a long time exclusively procured from plants, or "simples," as they were called, in contradistinction to those drugs which were afterwards compounded from the mineral or animal kingdoms.

The medical virtues of plants reside in almost all their different parts, sometimes in the roots, at others in the stem and leaves; sometimes they are exclusively confined to the bark, or to the flowers, seeds, or pericarps. These medicinal substances, too, assume various forms, as gums, resins, bitter extract, bland oils, or volatile aromatic essences. Several plants yielding many of these substances we have already described, as those yielding spices, essential oils, &c. In treating of the remainder of those plants most esteemed in medicine, we shall group them chiefly according to the effects which the substances they yield produce on the human body.

Peruvian Bark *(cinchona)*. Natural family, *contortiæ; pentandria, monogynia*, of Linnæus. There are several species of this genus, of which the following are supposed to yield the medicinal bark used in this country:

Cinchona condaminea, with ovo-lanceolate leaves and hairy corolla, which yields the pale bark or *cascarilla fina* of Uritasinga.

C. lancifolia, with lanceolate leaves, grows in an elevated temperate climate. Known in Santa Fé as the *quina naranjada*, rare.

C. cordifolia, with sub-cordate or oval leaves.

C. oblongifolia, with oblong acuminated leaves, common near Maraquita.

Common or Officinal Bark (c. officinalis). This tree attains a considerable height, sending off large branches covered with rough brown bark. The leaves vary from an ovate to an elliptical shape; the larger approaching more to the former, and the smaller to the latter figure. They are all entire, nerved, smooth on the upper side, on the under covered with dense hairs, and stand in pairs upon rather short foot-stalks. The flowers are produced in panicles, and stand upon slender pedicles. The calyxes small, bell shaped, and divided on the margin into five minute segments. The corolla is funnel-shaped, consisting of a long cylindrical tube divided at the limbs into five segments, which are ovate, oblong, cer-

rated at the edges, and tinged of a pink hue in the centre. The filaments are five, bristly, and

195.

Peruvian Bark Tree.

placed in the middle of the tube. The germen is ovate. The seeds, which are numerous, are contained in a two-celled capsule. This tree is a native of Peru, growing most abundantly on a long chain of mountains extending to the north and south of Lima. Formerly it was not unfrequent to find trees with a trunk as large as a man's body; now since the demand for the bark has increased, there are only young and much smaller trees to be seen.

The soil in which the tree thrives best, is a red clayey or rocky ground on the banks of mountain streams or rivers.

The proper season for cutting the bark is, according to Mr Arrot, from September to November, the only months in the whole year in which the rainy season wholly intermits among those mountains. Having discovered a plain where the trees most abound, huts are then built for the accommodation of the workmen, and a large one to contain the bark, in order to protect it from the wet. The workmen then clear a road through the forest to the nearest plantation, or farm houses in the low country, to which in dry weather they convey the bark as it is procured, accumulated in the temporary hut. Each Indian or wood-cutter is provided with a large knife, and a bag that will hold about fifty pounds of green bark. Every two Indians take a tree, from which they slice down the bark as far as they can reach from the ground. They then take sticks about half a yard long each, which they tie to the tree with tough withes at proper distances, like the steps of a ladder, always slicing off the bark as far as they can reach, before they fix a new step; and thus mount to the top, the Indian below gathering what the other cuts. This they do by turns, and go from tree to tree [illegible] is full, which, when they have plenty of tre[illegible] one Indian will do in a day. Great care must be taken that the bark is not cut when wet, and if this should happen to occur, it must be immediately taken down to the low country to be dried; for, if heaped up in a wet state, it loses its colour, turns black, and becomes useless.

The bark, as it is cut, is, therefore, as soon as possible conveyed down to the low country by mules, where it is spread out to dry. On the trees being entirely stripped of the bark, the trunks soon perish; but, according to Condamine, in a short time fresh shoots are sent up from the roots.

Like most other valuable discoveries, that of the medicinal efficacy of Peruvian bark, would appear to have been accidental. Indeed, the time or manner of this discovery is not well ascertained. Some contend that its use in intermittent fevers was known to the American Indians long before the invasion of that country from Europe, and that the natives carefully concealed its virtues from the Spaniards who invaded Peru. Others again assert, that the Peruvians never appropriated the bark to any use whatever, but imagined that the large quantities exported from their country by the Spaniards was for the purpose of dyeing; and, according to Ulloa, they actually made some trials of its effects in this art. Condamine says, that according to an ancient tradition, the Americans owe the discovery of this remedy to some wild beasts which were remarked to resort to the bark for the cure of the disease. Geoffrey states, with more appearance of reality, that the use of the bark was first learned by the following circumstance:—Some *cinchona* trees being thrown by the winds into a pool of water, lay there till the water became so bitter, that every one refused to drink it. However, one of the neighbouring inhabitants being seized with a violent paroxysm of fever, and finding no other water to quench his thirst, was forced to drink this, by which he was almost immediately cured of his fever. He afterwards related the circumstance to others, and prevailed upon some of his friends, who were ill of fevers, to make use of the same remedy, with whom it proved equally successful. The use of this medicine, however, was very little known till about the year 1638, when a signal cure having been performed by it on the Spanish Viceroy's lady, the Countess del Cinchon, at Lima, it came into general repute, and hence obtained the name of the Countess powder or cinchona. On the recovery of the lady, she distributed a large quantity of the bark to the Jesuits, in whose hands it acquired still greater reputation; and by them it was first introduced into Europe. Louis XV., when Dauphine, is said to have been one of the first in Europe who

experienced its efficacy. Cardinal de Lago, a benevolent Italian ecclesiastic, also brought a large quantity of the powder to Rome, and distributed it among the poor

The bark is brought to this country in pieces of various sizes, some rolled up into short thick quills, and others flat; the outside is brown, and generally partially covered with a whitish moss; the inside is of a yellowish, reddish, or rusty iron colour. The best sort breaks close and smooth, and proves friable between the teeth; the inferior kinds appear, when broken, of a woody texture, and in chewing, separate into fibres. The former pulverizes more easily than the latter, and looks, when powdered, of a light brownish colour, resembling cinnamon, or somewhat paler. It has a slight smell, approaching somewhat to mustiness; yet, with a degree of aromatic flavour which renders it not disagreeable. Its taste is very bitter, astringent, durable in the mouth, and accompanied with some degree of aromatic warmth, but not sufficient to prevent its being ungrateful.

There are three kinds known in commerce, the pale, yellow, and red.

Pale Bark. Of this kind there are several varieties, the most remarkable of which are the quilled bark, which comes from Lixa, and the flat bark from Guanaco. That which comes from Lixa consists of thin singly or doubly rolled pieces, four or five inches long, and scarcely a line in thickness; externally rough, of a grayish brown colour, and generally covered with a kind of lichen, internally of a cinnamon colour; its fracture not fibrous and powdery, but even and shining. It has a pleasant bitter astringent taste, and a peculiar aromatic smell. The bark which comes from Guanaco, consists of much thicker, coarser, and flatter pieces, externally of a dark brown or almost black colour, though internally of a cinnamon colour, and in its resinous fracture, smell, and taste, it exactly resembles the former. When genuine, both varieties are excellent remedies, although the former are generally preferred on the Continent, and the latter in Britain.

Yellow Bark. This consists of pieces about six inches in length, thicker, and less rolled up than the common bark. Its internal surface is of a deeper red. It sometimes wants the epidermis, which is often as thick as the bark itself. It is lighter and more friable than the former variety; its fracture is fibrous, and when reduced to powder, its colour is paler. Its taste is much more bitter, astringent, and stronger, but its smell is weaker. Its decoction, when hot, is redder, but when cold, paler. Its solution strikes a deeper colour with sulphate of iron. It contains more of the active constituents, but less gum than the common, and less resin than the red. Its medicinal effects are said to be much more powerful than the others; and, according to Humboldt, it is most esteemed at Lixa, and known by the name of *cascarilla fina.*

Red Bark occurs generally in larger, thicker, and flatter pieces, but sometimes also in the form of quills. It is heavy, firm, sound, and dry, friable between the teeth, does not separate into fibres, and breaks not shivery, but short, close, and smooth. It has three layers, the outer is rugged, of a reddish brown colour, but frequently covered with mossy matter. The middle is thicker, more compact, darker coloured, very resinous, and brittle, the inmost is more woody, fibrous, and of a brighter red. Its powder is of a dark red colour, its astringency and bitterness more intense, and its resinous properties greater, than that of the pale bark. According to Humboldt, from 12,000 to 14,000 quintals of bark are annually exported from Peru; 2000 are exported from Carthagena, and come from the kingdom of Santa Fe; Lixa furnished, previous to 1779, 10,000 quintals, but now only 110, which are sent to Spain on account of the king. The rest is furnished by the provinces of Huamunga, Cuenco, and Jaen de Bracamorros, and are exported from Lima and other parts of the Pacific ocean.

The powder of the bark at first acquired its reputation for the cure of ague or intermittent fever, and it has retained its reputation ever since. At first many prejudices were raised against it, but these gradually gave way to repeated facts, and the test of experience. Given at the very commencement of the disease, after the stomach and bowels have been cleared by some purgative, and repeated in successive doses, it is the only remedy now to be depended upon, and rarely fails of producing a cure. It is thus to be continued till the peculiar paroxysms of the disease go off, and till the natural appetite and strength return. It is then to be gradually left off, repeating it in smaller quantities occasionally, to prevent any symptoms of a relapse. Besides intermittents, it is used in other diseases which have a periodical return, and all those affections which indicate impaired nervous influence, or loss of tone of the animal fibre. The bark itself is not, however, now administered in almost any form, *quinine*, or the active agent, being extracted from the bark by a peculiar process, and now substituted as a medicine. This is a light white powder without smell, but possessing an intensely bitter taste, and reckoned by chemists of an alkaline nature. Its small bulk, and the readiness by which it can be dissolved in water or acids, and its producing no sickness or irritation of the stomach, are all recommendations to its substitution in place of the common powder of bark. On the whole, the virtues of Peruvian bark are of the most valuable and powerful kind, and it forms one of the most

esteemed medicines which the discovery of America has bestowed on the human race. It was of course entirely unknown to the ancients, and was first used with success and extensively in Britain, by Sydenham, Martin, and Lister.

Quassia *(quassia amara)*. *Decandria*, *Monogynia*, of Linnæus. This tree attains a medium

196.

Quassia.

height, sends off many strong branches, and is not unlike the common ash in its general appearance, inhabiting the same countries. Its name, as will be more particularly mentioned hereafter, has immediate reference to the medicinal value of the strong bitter which pervades all parts of the tree, but more especially the bark. The wood is light, and of a white colour. The bark is thin and grayish. The leaves are placed alternately upon the branches, and consist of two pairs of opposite pinnæ, with an odd one at the end. All the leaflets are of an elliptical shape, entire, veined, smooth, pointed, sessile, on the upper side of a deep green colour, on the under paler. The common foot-stalk is articulated, and winged, or edged on each side with a leafy membrane, which gradually expands towards the base of the pinnæ. The flowers are all hermaphrodite, of a bright red colour, and terminate the branches in long spikes. The bracteæ, or floral leaves, are lance-shaped or linear, coloured, and placed alternately upon the peduncles. The calyx is small, persistent, and five toothed; the corolla consists of five lance-shaped equal petals, at the base of which is placed the nectary or five reddish coloured scales. There are ten filaments with simple anthers. The germen is ovate, divided into five parts, and supports a slender style with a tapering stigma. The capsules are five, two-celled, and contain globular seeds. This tree is a native of South America, particularly of Surinam, and also of some of the West India islands. It was named quassia by Linnæus, from a negro called Quassi, who employed it with great success in Surinam, as a secret remedy in the malignant endemic fevers of that country. In consequence of a valuable consideration, this secret was disclosed to Daniel Rolander, a Swede, who brought specimens of the quassia to Stockholm in the year 1756, and since then the effects of this drug have been very generally tried in Europe; and numerous testimonies of its efficacy have now confirmed its value as a tonic and febrifuge.

The root, bark, wood, and even the leaves and flowers, all possess the peculiar bitter principle. The wood of the trunk and roots is that part now generally brought to this country. The bark, however, is more intensely bitter than the wood, and seems the most powerful as a medicine. Quassia has no sensible odour, its taste is that of a pure bitter, more intense and durable than that of any other known substance. It imparts this bitter to water more completely than to alcohol, or any other liquid; and the infusion is not blackened by any of the salts of iron. The medicinal virtues of quassia are those of a tonic, stomachic, antiseptic, and febrifuge. It has been found very effectual in restoring the tone of the stomach, producing appetite for food, assists digestion, expelling flatulency, and removing habitual costiveness produced from debility of the intestines, and that inaction of them consequent upon a sedentary life.

Dr Lettsom says, "In debility succeeding febrile diseases, the Peruvian bark is most generally more tonic and salutary than any other vegetable bitter hitherto known; but in hysterical attacks, to which the female sex is so prone, the quassia affords more vigour and relief to the system than the other. In debility arising from intemperance, and in laxity of the bowels, it is also very efficacious." But he adds, "With respect to its superiority to the Peruvian bark, as a tonic and febrifuge, I by no means subscribe to the Linnæan opinion. It is indeed very well known, that there are certain peculiarities of the air, and of the human constitution, unfavourable to the exhibition of the Peruvian bark, even in the most clear intermissions of fever, and writers have repeatedly noticed it, but this is comparatively rare. About midsummer, 1785, I met with several instances of low remittent and nervous fevers, wherein the bark uniformly aggravated the symptoms, though given in intermission, the most favourable to its success, and wherein quassia, or snake root, was successfully substituted. In such cases I mostly observed, that there was great congestion of the liver, and the debility at the same time discouraged copious evacuations. And in many fevers, without evident remissions to warrant the use of the bark, whilst at the same time increasing debility began to threaten life, these two medicines, quassia and snake root combined, upheld the vital powers, and promoted a critical intermission of the fever, by which an opportunity was afforded to effect a cure by means of the Peruvian bark.

The usual way in which quassia is prepared

as a medicine, is to infuse half an ounce of the wood shavings in sixteen ounces of water, for twelve hours. Then strain off the pure liquid, and take a small wine glassful twice a day, or oftener, according to the nature of the complaint. A few drops of elixir of vitriol will add to the efficacy of the infusion.

Quassia is used by some brewers to give the necessary bitterness to malt liquors. This in Britain is not legal, but it is not contrary to health.

The intense bitter of this wood destroys insects; hence an infusion of quassia is a common and safe poison for flies.

Simaruba, or Winged-leaved Quassia, is another species possessing the same, or even a more intense bitter than the other. It is known in Jamaica by the name of mountain damson, bitter damson, or slave-wood. It grows to a considerable height and thickness, and sends off alternate spreading branches. The bark which covers the trunks of the old trees is black, and a little furrowed, but that of the younger trees is smooth, gray, and here and there marked with broad spots of a yellow colour. The wood is hard, white, and without any remarkable taste. The leaves are numerous, and stand alternately on the branches; each leaf is composed of several pinnæ, nearly of an elliptical shape; on the upper side smooth, and of a deep green colour; on the under side whitist; they stand on short foot-stalks. The flowers are of a yellow colour, and placed on branched spikes or long panicles. They are male and female; and, according to Dr Wright, the female flowers are never found in Jamaica on the same trees with the male.

The bitter principle resides in the bark of the roots. This bark is rough, scaly, and wasted; the inside, when fresh, is a full yellow, but when dry, paler. It has little smell; the taste is bitter, but not disagreeable. Macerated in water, or in rectified spirits, it quickly impregnates both with its bitterness, and after becomes a yellow tincture. It seems to give out its virtue more perfectly to cold than to boiling water, the cold infusion being rather stronger in taste than the decoction, which last is of a transparent yellow colour, when hot; but grows turbid, and of a reddish brown as it cools. This bark was first sent from Guiana to France in 1713, as a remedy for dysentery. In the years 1718 and 1725, an epidemic flux prevailed very generally in France, which resisted all the medicines usually employed in such cases. Under these circumstances, recourse was had to the Simaruba, which proved remarkably successful, and first established its medical character in Europe. Dr Wright says, most authors who have written on this medicine agree, that in fluxes it restores the lost tone of the intestines, allays their spasmodic motions, promotes the secretions, removes the lowness of spirits attending the disease, and disposes the patient to sleep. In a moderate dose it occasions no disturbance or uneasiness, but in large doses it produces sickness and vomiting. More extended experience has shown, that this medicine is only successful in the latter stage of dysentery, when there is no fever, when the stomach is in no way affected, and when there only remains a relaxation and weakness of the bowels. In such cases, a glassful of the decoction given every five or six hours, with a few drops of laudanum, has been found very efficacious. It has been particularly recommended in old affections of the kind contracted in warm climates, and existing in debilitated habits. Such are the recommendations of this medicine at a period shortly after its discovery. Like many other remedies, it has now fallen into comparative neglect. Dr Cullen did not seem to think that it possessed virtues superior to the other bitter tonics, and in dysentery preferred an infusion of chamomile flowers.

A quarter of an ounce of simaruba may be infused for twelve hours in twelve ounces of cold or boiling water, and a wine glassful of the infusion taken every three or four hours.

Gentian *(gentiana lutea)*. Natural family, *rotaceæ; pentandria, digynia*, of Linnæus. This

197.

Gentian.

is an herbaceous plant, possessing bitter qualities in a considerable degree. The root is perennial, long, cylindrical, externally brown, internally yellowish. The flower stem is strong, smooth, erect, tapering, and rises two or three feet in height. The leaves, which proceed from the lower part of the stem, are spear-shaped, large, entire, ribbed, sessile, and pointed; those on the upper part are concave, smooth, egg-shaped, and of a pale or yellowish green colour. The flowers are large, yellow, produced in whorls, and stand upon strong peduncles. The corolla consists of five long narrow elliptical petals. The capsule is conical, one-celled, and contains numerous seeds. This plant is a native of the Alps, and was introduced into Britain by Gerard. Our British supply, however, comes from Switzerland and Germany. The root, which is the only

part of the plant used in medicine, has no smell, but has an extremely bitter taste. This bitter principle is readily yielded to alcohol and water, but more so to the former than to the latter. Gentian possesses the general virtues of bitters in an eminent degree, and it is totally devoid of astringency. On dead animal matter it acts as an antiseptic. Taken into the stomach, it proves a powerful tonic, and in large doses acts as a laxative.

The Purple Gentian (g. purpurea), is another species, having similar properties to the yellow. It is a native of the Alps, and was first introduced into this country for the purpose of cultivation by Saussure, in 1768. The root is perennial, cylindrical, slender, branched, externally of a brown colour, and yellow in the inside. The stem grows erect to the height of a foot, is simple, smooth, strong, succulent. The lower leaves are nearly elliptical, ribbed, and entire. The upper leaves are in pairs, sheath-like, concave, pointed, ribbed, embrace the stem, and enclose the flowers. These are of a purple colour, and stand in whorls upon short peduncles. The calyx is a deciduous scape; the corolla bell-shaped, plaited, and of a purple colour; the ovate two-celled capsule containing numerous seeds. The root, both in appearance, taste, and medicinal qualities, exactly resembles the other, and may be employed for the same uses. It is said that the Swiss and other peasants of the chill Alpine parts of Europe use a decoction of the gentian and other bitter roots, as a cordial drink; and it is probable it may prove a wholesome tonic and stimulant in those moist and inclement regions which they inhabit. Gentian and the root of the *acorus calamus*, or sweet flag, form the chief ingredients in the Stockton and other bitters used by the common people of this country. The great objection to them is the strong spirituous menstruum in which they are infused. An infusion in simple water, with as much spirits as would be sufficient to prevent putrefaction, would be equally useful, and less productive of abuse.

Centaury *(chironia, centaurium)*. *Pentandria, monogynia*, of Linnæus. This plant was originally classed with the gentians by Linnæus, from which family, however, it essentially differs. The root is annual, woody, fibrous, and of a yellowish colour. The stalk is erect, with few branches, smooth, angular, and usually rises from six to ten inches in length. The leaves are opposite, sessile, smooth, oblong, ribbed, and blunt at the points. The flowers are terminal, produced in a bunch, with five pinkish-coloured petals. The plant is common in Britain in woods and pastures, and flowers in July.

The centaury was formerly much used, both by physicians and by the country people, as a bitter. It is less employed in modern times, although the testimony of Cullen, Lewis, and other writers on medicinal plants, is highly favourable to its virtues. The tender leaves, shoots, and flowers of the top of the plant, are those parts of it used. Its active parts are dissolved readily both by water and rectified spirit; the herb, after infusion in sufficient quantities of either fluids, being quite insipid. Water takes up along with the bitter a large quantity of an insipid mucilaginous substance, whereas rectified spirit seems to dissolve little more than the pure bitter part. Hence, on evaporating the two solutions to the same consistencies, the watery extract proves much less bitter than the spirituous, while its quantity is above four times greater. "The centaury," says Dr Woodville, "is justly esteemed to be the most efficacious bitter of all the medicinal plants, indigenous to this country. It has been recommended by Dr Cullen as a substitute for gentian, and by several thought to be a more useful medicine. Experiments also prove, that it possesses an equal degree of antiseptic power. Many authors have observed, that along with the tonic and stomachic qualities of a bitter, it frequently proves laxative; but it is probable that this seldom happens unless the dose be very large. The use of this, as well as the other bitters, was formerly common in febrile disorders previous to the knowledge of Peruvian bark, which now supersedes them perhaps too generally, for many cases of fever occur which are found to be aggravated by the cinchona, yet afterwards readily yield to simple bitters."

198.

Centaury.

Its use as a vermifuge depends upon its bitter qualities and hence it will be found more efficacious for strengthening the bowels, after the expulsion of worms by other more powerful medicines, and thus preventing their return.

Water Trefoil, or Buck Bean. *Pentandria, monogynia.* This is a very common plant in Britain, growing in marshes and by the sides of ponds, and flowers about the latter end of June. The stalk rises from a sheath to the height of six or twelve inches. The leaves are ternate, waved at the margins, and resemble the common bean; hence the common name of buck bean. The petals are pink coloured on the outside, and within finely fringed, so as to have a fibrous or hairy appearance. The root is perennial, jointed, and sends forth many long slender filaments. The whole plant is so extremely bitter, that in some countries it is used as a substitute for hops in the preparation of malt liquor; yet, according to Linnæus, the poorer people in Lapland make a bread of the powdered roots mixed

with meal, although it makes a very unpalatable food. The juice contains a large proportion of astringent matter, producing a deep black precipitate with the salts of iron. A dram of the powdered leaves will also act on the bowels as a purgative, and produce vomiting, so that, besides its tonic properties, it seems to possess other medicinal powers. It has accordingly been employed for the cure of a variety of diseases, as scurvy, dropsy, jaundice, &c. Dr Boerhaave and others experienced its effects in removing a fit of gout; it is said to have cured sheep ill of the dropsy; and Dr Cullen mentions, that it has proved efficacious in some kinds of cutaneous diseases. It has, however, in modern practice, fallen into disuse. The leaves may be used in powder, or infused in water or spirits.

Common Camomile. Natural family, *compositæ;* class *syngenesia, polygamia superflua,* of Linnæus. This well known plant is a perennial, with slender, trailing, hairy, and branched stems. The leaves are doubly pinnated, with linear pointed pinnæ. The flower is white, with a yellow centre. This plant was known to the Greeks, and obtained the name it now bears, which is expressive of its peculiar smell. It is the *anthemis* of Dioscorides and Theophrastus. The corn feverew is similar to the camomile in appearance, and is used on the continent in medicine; but it is less fragrant, and contains less oil than the latter. There is a double variety sometimes kept in the shops, but the single is preferable, as the essential oil on which its aromatic qualities depend, is contained in the external disk, or tubular part of the male florets. Both leaves and flowers of this plant have a strong, though not ungrateful smell, and a very bitter nauseous taste; but the flowers are more bitter and aromatic than the leaves. The flowers give out their virtues both to water and rectified spirits. When the flowers are dried and powdered, the infusions are more grateful than from the fresh, or but moderately dried. Distilled with water, an essential oil in small quantities is obtained, of a greenish colour, and strong pungent taste. Rectified spirit also extracts, and in some degree conceals, the odour of this oil; and the bitter taste of the tincture is stronger than that of the watery infusion.

These flowers possess the tonic and stomachic qualities usually ascribed to simple bitters, having very little astringency, but a strong odour of the aromatic and penetrating kind; hence they are also of a stimulating nature, and in some degree allay nervous irritability. They were formerly much used in the cure of intermittent and other similar fevers, and have in some instances been substituted for the Peruvian bark. Dr Cullen has administered from half a dram to a dram of the powder, during the intermissions of ague, and with success, only that on account of the laxative quality he had to give with them an opiate. They have also been found useful in hysterical affections, flatulent colic, and dysentery. At present they are perhaps less used than they deserve to be. A simple infusion of them is frequently taken to induce vomiting, or assist the operation of an emetic; and in fomentations to external parts, and for the formation of poultices, they are still in request.

Spanish Camomile or Pellitory. This plant resembles the other, only the flowers are considerably larger, and less numerous. It is a native of the Levant, and the southern parts of Europe, and was introduced into England by Lobel, in 1750, but it does not ripen its seeds unless in favourable seasons. The root has a very hot pungent taste, without any sensible smell. This pungency resides in a fixed resinous matter, only partly soluble in water.

It is said that the ancient Romans employed this root as a pickle, and indeed it seems less acrid than most substances now used for this purpose. In its recent state it is not so pungent as when dried, yet, if applied to the skin, it produces great irritation, and even inflammation.

The aromatic and stimulating properties of this root point it out as an appropriate medicine, when such stimulants are necessary. Its use, however, has hitherto been chiefly confined to that of a masticatory, and it has been employed for this purpose from a very early date. On being chewed or retained for some time in the mouth, it excites a glowing heat, stimulates the salivary ducts, and causes a discharge which has been found to relieve toothache and rheumatic affections of the gums and fauces, and has been recommended in paralysis of the tongue.

Southern Wood *(artimisia abrotanum.)* This is another plant possessing bitter qualities, and belonging to the same natural family as the foregoing. The root is perennial, woody, and fibrous. The stalk is shrubby, covered with brown bark, and rises to the height of two or three feet. The leaves are numerous, doubly pinnated, hoary, and stand on long foot-stalks. The flowers are compound, composed of numerous small florets of a yellow colour. The seeds are naked and solitary. It is a native of France, Spain, and Italy, and was introduced into this country by Gerard, where it grows luxuriantly, but rarely flowers. It is to be found in almost every cottage garden. The leaves and tops have a strong, and to most people an agreeable smell. The taste is pungent, bitter, and somewhat nauseous. These qualities it yields to spirits readily, and tinges the liquid of a green colour. Water extracts them less perfectly, and the infusion is of a light brown tint. It yields a very small portion of essential oil by distillation.

This plant was much employed by the ancient physicians, and was esteemed as stomachic and

stimulating to the system. It is now, however, entirely laid aside by modern physicians, and is prized chiefly on account of its fragrant odour.

WORMWOOD *(artimisia absinthium.)* This belongs to the same family as the foregoing. The root is perennial, the stem is ligneous, downy, and grows to the height of two or three feet. The leaves are compound, and divided into many blunt segments, and downy on the under side. The flowers are brownish yellow, and placed in numerous spikes. It grows wild in this country about rocks and rubbish. The leaves have a strong disagreeable smell, their taste is nauseous, and so intensely bitter, as to be proverbial. The flowers are more aromatic and less bitter than the leaves, and the roots have an aromatic warmth, without any bitterness. Linnæus says, that the plant communicates a bitter taste to the milk and even flesh of cows and sheep that feed on it; and that the milk of a woman who took the extract became extremely bitter. The leaves and flowers yield the bitter both to water and spirits. The flowers form the most agreeable and grateful tincture. This plant is supposed to be the *absinthium penticum* of Dioscorides and Pliny. Besides its strictly tonic powers, for which it has been used by the moderns, it is also supposed to possess certain narcotic qualities, which act on the nerves of the stomach, and those of the head. It is used to form an ingredient of a kind of ale called *purl*, and this drink was found to affect the head much more quickly and strongly than malt liquor alone. Its power of destroying worms is not more than the ordinary class of bitter substances. It is now rarely used as a medicine.

May Wort (artimisia vulgaris). This plant is also common in Britain, and resembles the former in its general properties and appearance. The leaves have a light agreeable smell, especially when rubbed, but scarcely any taste. The flowery tops are somewhat stronger than the leaves. This plant is rarely used now, although it was much employed by Hippocrates, Dioscorides and Galen, in uterine complaints, in which it is employed by the Chinese of the present day.

Moxa is a substance prepared in Japan from the dry tops and leaves of May wort, by beating and rubbing them between the hands till only the fine woolly fibres of the inside remain, which are then combed, and formed into little cones. Those used as cauteries are greatly celebrated in Eastern countries for the cure of many disorders. The manner of applying the moxa is very simple. The part affected being previously moistened, a cone of the moxa is laid, which being set on fire at the apex, gradually burns down to the skin, where it produces a dark-coloured spot; by repeating the process several times, an eschar is formed of any desired extent, and this on separation leaves an ulcer, which may be kept open as long as required. It is said that the use of the moxa was originally introduced by the Jesuits, but it is probably of greater antiquity. Hippocrates, for a similar purpose, used flax, and also a species of fungus; and the Laplanders to this day use the agaric in a similar way. The Egyptians employed cotton or linen for a similar purpose.

The Chinese also manufacture a paper and a kind of cloth, from the down of the artimisia.

HYSSOP *(hyssopus officinalis).* Natural family *labiatæ; didynamia, gymnospermia*, of Linnæus. This is a perennial, shrubby plant, which rises to the height of two feet. The leaves are long, narrow, and elliptical, of a deep green colour, and stand in pairs without footstalks. The flowers are produced chiefly on one side, in short verticellated spikes terminating the branches, and are of a blue colour. It is a native of Siberia and the mountainous parts of Austria, and flowers from June till September. This is not supposed to be the hyssop mentioned in the Old Testament; nor, indeed, is it at all ascertained what is the *esof* of the Hebrews, or the *hyssopus* of the Greeks. It appears to have been one of the smallest plants, and "grew out of the wall;" hence some have conjectured it to be one of the mosses.

Hyssop was first introduced and cultivated in England by Gerard, in 1596, and is now common in gardens. The leaves have an aromatic smell, and a bitterish, moderately warm taste. They give out their action both to water and spirits, but more perfectly to the latter. The spirituous extract possesses little of the flavour of the plant, but has a warm aromatic taste, like camphor. The watery distillation of the fresh herb yields an essential oil, having the flavour of the plant. Its medicinal properties were held in some estimation by the older physicians, but it has now fallen into disuse. Dr Cullen reckons it aromatic and stimulating; and it was used in asthma and other affections of the chest, as an expectorant: for this purpose an infusion of the leaves is drunk as tea. Externally, decoctions of the leaves are used in bruises and indolent swellings.

RUE *(ruta graveolens).* Natural family *rutaceæ; decandria, monogynia*, of Linnæus. The root sends forth several shrubby stalks, which, towards the bottom, are strong, woody, and covered with a rough, gray, striated bark. The upper or young branches are smooth, and of a pale green colour; the leaves are compound, consisting of double sets of irregular pinnæ minutely notched, oval shaped, and of a glaucous blue colour. The flowers are numerous, the petals, consisting of four or five, are yellow. This shrub is a native of the south of Europe, and flowers in June and September.

Rue was much used by the ancients, who ascribed to it many virtues. Hippocrates praises it as a diuretic, and attributes to it the power of resisting the contagion of fevers, as well as other poisons; and with this view it was used by Mithridates. Boerhaave even gave it credit for these virtues; but it is now almost entirely laid aside as a medicine. In Shakespeare and other authors, it is called herb of grace, as rosemary is called herb of remembrance.

The first account we have of the cultivation of rue in Britain is given by Turner, who published his herbal in 1562. It is now a very common plant in gardens, where it retains its verdure the whole year. It has a strong, ungrateful smell, and a bitter, hot, penetrating taste. The leaves are so acrid, that by much handling they are said to irritate and influence the skin; and the plant, in its natural or uncultivated state, is reported to possess these sensible qualities still more powerfully. Both water and rectified spirit extract its virtues, but the latter more perfectly than the former.

Its properties are no doubt highly stimulating, and adapted to phlegmatic habits where there is nervous irregularity of the system, and especially of the uterine system. Dr Cullen says, I have no doubt of its antispasmodic powers.

Horehound *(marrubium vulgare)*. Natural family *labiatæ; didynamia, gymnospermia.* This is a perennial plant, with hairy stalks, and oblong, deeply serrated leaves, which are also covered with a down. The flowers are white, and produced in whorls at the footstalks. It is a native of Britain, growing near the sides of roads and among rubbish, and flowers in June. The leaves have a moderately strong aromatic smell, which is rendered less disagreeable by drying, and keeping for some months. Their taste is very bitter, penetrating, diffusive, and durable in the mouth. The dry herb gives out its medicinal qualities both to water and spirits. This plant is the *prasion* of the ancient Greeks, by whom it was held in estimation as a cure for affections of the lungs and intestines. It was at one time a good deal employed as a cure for asthma, obstinate coughs, and affections of the chest; but it now seems to have fallen into disrepute. That it possesses some tonic and stimulating powers, cannot be disputed; but its former reputation as an active and useful medicine was no doubt overrated. The expressed juice of the fresh plant, or the dried leaves, taken either in powder or in an infusion in water or spirits, are the modes of administering this herb.

Balm *(melissa officinalis)*. This is another herb belonging to the same family as the above. It is a perennial, with stems two feet in height, with oblong, deeply serrated leaves, and a white flower.

This plant is a native of the southern parts of Europe, especially of mountainous districts. It was cultivated by Gerard previous to the year 1596, and is common in our gardens. The herb, in its recent state, has a weak, roughish, aromatic taste, and a pleasant smell, somewhat of the lemon kind, and hence it has been called lemon balm. A small portion of essential oil is obtained by distillation, of a yellowish colour and very fragrant smell. It is uncertain under what name it was known to the ancients. It was formerly esteemed of use in all nervous affections; and Paracelsus employed it in hypochondriacal diseases. The praises bestowed on it by the Arabic physicians probably sustained its reputation even to the time of Hoffman and Boerhaave; but it is now looked upon as a medicine of inferior powers, and little used. Prepared as tea, however, it makes a grateful and slightly stimulating drink in fevers. The essential oil recommended by Hoffman, seems to possess no other remarkable properties than that of a stimulating aromatic.

Ginseng *(panex quinquifolium)*. Natural family *aratiaceæ; polygamia, diœcia*, of Linnæus.

199.

Ginseng.

The fame which this plant has acquired in China, is not by any means maintained by the estimation in which it is held in Europe. It is a perennial, with a round purple stalk about a foot high. The leaves arise with the flower stems from a thick joint at the extremity of the stalk. They are generally three, but sometimes more of the digitated kind, each dividing into five simple leaves, which are of an irregular, oval shape, with serrated edges; smooth and pointed, and of a deep green colour. The flowers are produced in a round terminal umbel, and are of a whitish colour. They appear in June.

This plant was formerly supposed to be confined to Chinese Tartary, growing in mountainous situations shaded by close woods; but it is now known to be a native of North America, from whence Sarrasin transmitted specimens to Paris, in 1704; and the ginseng, since discovered in Canada and the United States, has been found to be identical with that of Tartary; so that its roots are regularly purchased by the Chinese, who consider them to be the same as that of

their own growth, though theirs undergoes a process whereby its appearance is rendered somewhat different. In China the roots are said to be washed or soaked in a decoction of rice, or millet seed, and afterwards exposed to the steam of this liquor, by which they acquire a greater firmness and clearness than in their natural state. The plant was first introduced into England in 1740, by that industrious botanist Peter Collinson. The dried root of ginseng, as imported here, is scarcely the thickness of the little finger; about three or four inches long, frequently forked, transversely wrinkled, of a horny texture, and both externally and internally of a yellowish white colour. To the taste it discovers a mucilaginous sweetness, approaching to that of liquorice, accompanied with some degree of bitterness, and a slight aromatic warmth, with little or no smell. It is far sweeter and pleasanter than the roots of fennel, to which it has been by some supposed similar, and differs likewise remarkably from those roots in its nature and properties; the sweet matter of the ginseng being preserved entire in the watery as well as in the spirituous extract, whereas that of fennel roots is destroyed or dissipated in the evaporation of the watery tincture. The slight aromatic flavour of the ginseng is likewise in a good measure retained in the watery extract, and perfectly in the spirituous.

The Chinese ascribe extraordinary virtues to the ginseng root, and have long considered it as a sovereign remedy in almost all diseases to which they are liable, having no confidence in any medicine unless in combination with it. It is observed by Jartoux, that the most eminent physicians in China have written volumes on the medicinal powers of this plant, asserting, that it gives immediate relief in extreme fatigue, either of body or of mind, that it dissolves superfluous and noxious humours, and eases respiration, strengthens the stomach, improves the appetite and digestion, allays vomitings, and almost any other ill that flesh is heir to. These and many other effects of this root equally extravagant, are related gravely by various authors; and Jartoux was so much biassed by this eastern prejudice in its favour, that he seems to have given them full credit, and confirms them in some measure by his own experience.

Osbeck says that he never looked into the apothecaries' shops in China but they were always selling ginseng; that both poor people and those of the highest rank made use of it; and that they boil half an ounce in their tea or soup every morning, as a remedy for consumption and other diseases. In Europe, however, experience has by no means borne out those assertions. It is seldom or never now employed, nor do its sensible qualities seem to produce any active effects.

The hardy species of this plant grows well in rich light soil, the others in loam and peat; they are propagated by cuttings in sand, under a hand glass.

Sweet-Flag *(acorus calamus)*. Natural family *aroideæ; hexandria, monogynia*, of Linnæus. This is one of the most pleasing and powerful of the aromatic bitters. It is a perennial. The root, which is the medicinal part, is about an inch in thickness, somewhat compressed, of a yellowish colour outside, and white and porous within. The leaves are long, sword-shaped, sheathing one another, and commonly undulated on one side. The flowers are small, numerous, and produced on a spadix, or conical spike at the edge of the leaf; they are of a greenish yellow. The capsule is oblong, three-celled, and contains numerous oval seeds. According to Linnæus, this is the only true aromatic plant indigenous to northern climates. It is common in many parts of England, and usually grows in stagnant waters, and by the sides of rivers, producing its flowers in May or June. The roots have been long medicinally employed, and were formerly imported here from Asia and the Levant; but those of English growth are now very generally substituted, and found to be little or nothing inferior to the exotic sort, which is merely a variety of the same species. The root, in its dried state, has a moderately strong aromatic smell, and a warm, pungent, bitter, taste. Water completely extracts this bitter principle, and rectified spirit that of the aromatic. Distillation with water affords a small proportion of aromatic oil.

Both the Greek and Arabian physicians employed this root as a medicine. It is pungent, warm, and bitter, though not so heating as the spices, and is used greatly in conjunction with the other simple bitters, to render them more grateful to the stomach. It has been administered in intermittent fevers, and with success even after the failure of Peruvian bark. According to Professor Thomson, it is too little used in modern practice.

White Canella *(canella alba)*. Natural family *oleraceæ; dodecandria, monogynia*, of Linnæus. This is a tree from ten to fifty feet in height, with a straight stem, branched only at the top. It is covered with a whitish bark, by which it is easily distinguished at a distance from other trees, in the woods where it grows; the leaves are placed upon short footstalks, and stand alternately. They are oblong, obtuse, entire, of a dark shining green hue, and thick like those of the laurel. The flowers are small, seldom opening, of a violet colour, and grow in clusters at the tops of the branches upon divided footstalks. The fruit is an oblong berry, containing four kidney-shaped seeds, of unequal size.

The whole tree is very aromatic, and when in blossom perfumes the whole neighbourhood. The flowers dried and softened again in warm water, have a fragrant odour, nearly approaching to that of musk. The leaves have a strong smell of laurel. The berries after having been some time green, turn blue, and become at last of a black glossy colour; and have a faint aromatic taste and smell. They are, when ripe, fed upon greedily by the wild pigeons in Jamaica, and impart a peculiar flavour to their flesh.

The canella was first introduced into Britain, according to Clusius, in 1600. The canella of commerce is the bark of the tree freed from its outward covering, and dried in the shade. It is brought to Europe in long quills, which are about three-quarters of an inch in diameter; somewhat thicker than cinnamon, and both externally and internally of a whitish or light brown colour, with a yellowish hue; and commonly intermixed with thicker pieces, which are probably obtained from the trunk of the tree. This bark is moderately warm to the taste, and aromatic and bitterish. Its smell is agreeable, and resembles that of cloves. Its virtues are extracted most perfectly by proof spirits. In distillation with water it yields an essential oil, of a dark yellowish colour, of a thick tenacious consistence, with difficulty separable from the aqueous fluid; in smell sufficiently grateful, though less so than the bark itself. The remaining decoction, when evaporated, leaves a very bitter extract, composed of resinous and gummy matter imperfectly mixed. Canella was frequently confounded with Winter's bark, another somewhat similar substance; but having more active qualities, the canella is now generally used. It has been supposed to possess a considerable share of active medicinal powers, and was formerly employed as a cure in scurvy. Now it is merely esteemed as a pleasing aromatic bitter, and as a useful adjunct in correcting more active, though nauseous medicines. The powder is given along with aloes, as a stimulating purgative. The negroes and Caribs are said to use it as a condiment to their food.

Tormentil *(tormentilla erecta)*. Natural family *rosaceæ; icosandria, polygynia*, of Linnæus. This little plant is seen rearing its yellow flower on our heaths and hills in great abundance. It is perennial, with a thick, round, knobbed root, of a dark brown colour, the interior of which has a reddish tinge. Its stems are about a span high. The stalk leaves are divided into seven; those of the branches into five parts; three of them are larger than the others; and all are elliptical and deeply serrated. The flowers stand singly on long stalks, and have four small yellow petals.

The root is the only part which is used in medicine. It has a strong styptic taste, but imparts no peculiar flavour. As a proof of its powerful astringency, it has been substituted for bark in the tanning of leather. It is still used in the western islands of Scotland for this purpose, and in the Orkneys. The roots are boiled in water, and the skins steeped in the cold liquor for a considerable time. In the islands of Tirey and Coll, the inhabitants have destroyed so much ground by digging them up, that they have been prohibited the use of them. They are also used for dyeing cloth of a red colour. In Killarney they feed pigs with the roots.

Tormentil was at one time in considerable esteem as an astringent medicine, especially in diarrhœa, although it has now fallen into disuse. Dr Cullen says it has been justly commended for every virtue that is competent to astringents. I myself, he adds, have had several instances of its virtues in this respect, and particularly have found it, both alone and combined with gentian, cure intermittent fevers; but it must be given in substance, and in large quantities.

This dry root is given in powder, or a decoction may be made by boiling it in water, and adding a little cinnamon.

Arbutus, or Bearberry *(arbutus uva ursi)*. Natural family *ericeæ; decandria, monogynia*, of Linnæus. This little plant is found in alpine regions at a considerable height. The root is perennial, long, branched, and fibrous. The stems are numerous, procumbent, woody, and scarcely a foot long, seldom divided into branches. The leaves are small, oblong, obtuse, without footstalks, of a dark green colour. The flowers are flesh-coloured, and terminate the stems in small clusters; the corolla is monopetalous; the fruit is a pulpy, round, red berry. It is common in the north of Scotland, and flowers in June. There is reason to suppose that this plant was used by Dioscorides and Galen, as a cure for spitting of blood.

The dry leaves are inodorous at first, though bitter; but on keeping and being powdered, have the flavour of hysson tea. They have been used to dye an ash colour, and are also sometimes employed in the tanning of leather. The *uva ursi*, though employed by the ancients in several diseases requiring astringent medicines, had almost entirely fallen into disuse till about the middle of last century, when its use was revived as a medicine in diseases of the kidneys and stone.

In the years 1763 and 1764 it rose into fashionable notoriety, for the cure of gravelly complaints, and, indeed, all affections of the urinary organs; and was much lauded by the German, French, and Spanish physicians. Time and further experience, however, proved all these encomiums to be exaggerated. The experiments of Drs Alexander and Murray show this sub-

stance to possess little diuretic power, and to have no material effect upon the urinary organs. Dr Cullen deems that its only beneficial effect arises from its astringent properties. Dr Withering says, "perhaps we shall find it no better than other vegetable astringents, some of which have long been used by the country people in gravelly complaints, and with very great advantage, though hitherto unnoticed by the regular practitioners." The leaves may be used either in powder or boiled in water. A small teaspoonful of the powder is given twice a-day.

Catechu (*acacia catechu*). Natural family *leguminosæ; polygamia, monœcia*, of Linnæus. The small tree which yields the valuable astringent called catechu, is a native of the mountainous parts of India. It attains the height of twelve feet, and one foot in diameter. The trunk is covered with a thick, tough, brown bark, and towards the top divides into many close branches. The leaves are bipinnated or doubly winged, and are placed alternately upon the younger branches. The partial pinnæ are nearly two inches long, and are commonly from fifteen to thirty pair, having small glands inserted between the pinnæ; each wing is usually furnished with about forty pair of pinnated or linear lobes, beset with short hairs. The flowers are hermaphrodite, and stand in close spikes, which arise from the axillæ of the leaves. The seeds are contained in lance-shaped pods.

The highly astringent substance long known under the name of *terra Japonica*, or more properly *catechu*, was long used in Europe before it was known how it was actually produced. Clusius and others supposed that this substance was extracted from the kernel of a nut, the produce of a species of palm, and confounded with the *areca* or beetle nut. According to Mr Kerr, however, in the province of Bahar, where the catechu is manufactured, the price of the areca nut far exceeds that of the catechu. But he thinks it probable that where this nut is in great plenty, they may perhaps join some of the fruit in making the extract to answer a double purpose; for the most frequent use of both is in chewing them together, as Europeans do tobacco; to these two substances they add a little shell lime, and a leaf called *pauw*.

The preparation of catechu is as follows:—

After felling the trees the manufacturer carefully cuts off all the exterior white part of the wood. The interior coloured wood is cut into chips, with which he fills a narrow-mouthed, unglazed, earthen pot, pouring water upon them until he sees it among the upper chips. When this is half evaporated by boiling, the decoction without straining, is poured into a flat earthen pot, and boiled to one-third part. This is set in a cool place for one day, and afterwards evaporated by the heat of the sun, stirring it several times in the day; when it is reduced to a considerable thickness it is spread upon a mat or cloth, which has previously been covered with the ashes of cow dung. This mass is divided into square or quadrangular pieces by a string, and completely dried by turning them frequently in the sun, until they are fit for sale. In making the extract, the pale brown wood is preferred, as it produces the finer whitish extract; the darker the wood is the blacker the extract, and of less value. This extract is called *cutt* by the natives. In its ordinary state it is a dry, pulverulent substance, outwardly of a reddish colour, internally of a shining dark brown, tinged with a reddish hue. In the mouth it discovers considerable astringency, succeeded by a sweetish, mucilaginous taste. It dissolves almost entirely in water, leaving only the impurities with which it is mixed, and which are of a sandy or earthy nature. Of the pure matter, spirits dissolves about seven-eights into a deep red liquor. The part undissolved is an almost insipid, mucilaginous substance.

In medicine this substance is employed in all cases where an astringent is required, especially in relaxed states of the intestines and uterine vessels. In ulcerations of the gums, mouth, or throat, it is also beneficial. In India an ointment is prepared, composed of four ounces of catechu, one ounce of alum, and half an ounce of white resin. These are reduced to a fine powder, and mixed with the hand, adding olive oil ten ounces, and a sufficient quantity of water. To all sores and ulcers in warm climates, astringent applications of this kind are found to be useful.

For internal use, a simple infusion in warm water, with the addition of a little cinnamon powder, is the best mode in which it can be prepared.

Mezereon (*daphne mezereon*). Natural family *thymeleæ; octandria, monogynia*, of Linnæus. The mezereon is a hardy shrub, and a native of England, though not very commonly to be met with in a wild state. It grows to the height of five or six feet, and sends off several branches. The exterior bark is smooth, and of a gray colour. The root is of a fibrous texture, of a pale colour, and covered with smooth, olive-coloured bark. The leaves are few, tender, lance-shaped, sessile, and deciduous, and appear at the termination of the branches after the flowers have expanded. The flowers surround the branches in thick clusters; they are sessile, monopetalous, tubular, having the limb divided into four oval segments, commonly of a purple hue. The seed is contained in a round reddish berry. In England this shrub is said to be frequently seen near Andover, in Hampshire, and Laxfield, in Suffolk. It is a common plant in gardens on account of the beauty of its early blowing flowers, which appear in February or March.

This plant is extremely acrid, especially when fresh; and if chewed and retained in the mouth, excites great and long continued heat and inflammation, particularly of the throat and fauces. The berries also have the same effects, and when swallowed, prove a powerful corrosive poison not only to man, but to dogs and other quadrupeds, though birds feed on them with impunity. The bark and berries formed into ointments and infusions, have long been used as external applications to old ulcers and long continued sores. In France the bark is used as an application to the skin, and, under certain management, produces a continued serous discharge without blistering, and is thus rendered useful in many chronic diseases of a local nature, answering the purpose of what has been called a perpetual blister, while it occasions little pain or inconvenience. The mode of application is as follows: A square piece of the recent bark about an inch long, and three-quarters of an inch broad, macerated a little in vinegar, is applied to the skin, over which is bound a leaf of ivy or plantain. This application is at first renewed night and morning, till it cauterises the part and brings on a serous discharge, when a renewal of the bark once in twenty-four hours is found sufficient to continue the issue for any length of time. By means of a piece of adhesive plaster, pieces of the bark might thus be applied behind the ears, or at the back of the neck, for diseases of the eyes, &c.

In an affection of the throat of three years' standing, where there was great difficulty of swallowing, Dr Withering directed the mezereon root to be chewed frequently, and a complete cure was thus effected in a month. The root of the mezereon is very large, and possesses even more acridity than the bark. Slices of the root are frequently chewed in the mouth for toothache.

Mezereon has also been employed in decoction, either alone or joined with sarsaparilla in the secondary forms of syphilis, and in the cure of schirrous tumours.

Arum, or Wake-Robin *(arum maculatum); monœcia polyandria.* This plant has already been alluded to as yielding a farinaceous substance from its roots. In a recent state the juice of this root, which is extremely acrimonous, has been used as a medicine. The plant grows wild in Britain, and is in some respects remarkable. The root is perennial, about the size of a large nut, and sends off many long fibres. The leaves are commonly three or four, growing from each root. These are arrow-shaped, of a deep green or purplish colour, with numerous veins and dark spots. The flower stalk is very short; the calyx is a sheath of one leaf, large, oval, and inclosing the spadix, which is round, club-shaped, fleshy, above of a purple colour, below whitish, standing in the centre of the sheath, and supporting the parts necessary to fructification. Towards the base are several oval corpuscles or nectaries; next to them are placed the antheræ, under them are more nectaries; and lastly, the germina with bearded stigmata. This curious flower shows itself early in spring, but the berries which follow do not ripen till late in summer, when they appear in naked clusters, of a bright scarlet colour.

The root, when recent, contains a milky fluid, which is extremely acrimonious, exciting a painful sensation of burning heat in the tongue and mouth. When cut in slices and applied to the skin, it produces a blister. By drying, it loses this activity; and exposed to a sufficient heat for a short time, there remains the starchy substance, described in another place.

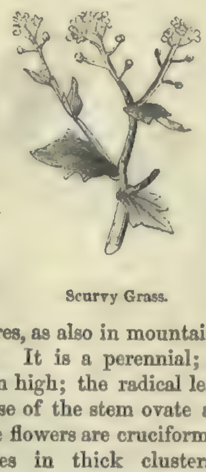
The recent root does not impart its acrimony to spirits, wine, or water; the juice, however, is reckoned a powerful stimulant and diuretic, not only exciting the languid digestive organs, but also the whole system. By the ancients it was used both externally and internally, but has fallen into disuse in modern practice where fresh herbs of any kind are so seldom resorted to.

The root should be young, and slightly dried in the shade and without heat. A scruple of this root, pounded, or made into an emulsion with gum Arabic, may be given once or twice a day; or the fresh root pounded may be used in the same way, in cases of rheumatism.

It occasions a slight warmth in the stomach, and afterwards promotes perspiration, and has frequently been known to cure chronic rheumatism and severe headaches, arising from nervous debility of the stomach.

Scurvy Grass *(cochlearia officinalis); tetradynamia, siliculosa.* This plant is common on our sea shores, as also in mountainous situations in Britain. It is a perennial; the stems are about a span high; the radical leaves are heart-shaped, those of the stem ovate and deeply serrated. The flowers are cruciform and terminate the branches in thick clusters. It has an unpleasant smell, and a warm acrid bitter taste. As a medicine, it is aperient, diuretic, and generally stimulating. The fresh plant, eaten as a

200.



Scurvy Grass.

salad, is found to be one of the best cures for scurvy, brought on by long sea voyages and a diet of salted provisions. This disease has, however, in a great measure been obviated in modern times by a supply of citric acid or lemon juice on board of ship; and in domestic diet great and important improvements have taken place by the continued supply all over the year of fresh provisions, and abundance of vegetables.

Assafœtida (*ferula assafœtida*). Natural family, *umbelliferæ; pentandria, digynia*, of Linnæus. The well known gum assafœtida is the juice of several species of a plant which in its general appearance and habits resembles hemlock. Dr Hope was the first who introduced this plant into Europe; and in 1784, a fine specimen grew in the botanic garden of Edinburgh. The plant is a native of Persia; the root is perennial, tapering, and grows to the size of a man's arm; it is covered with a dark coloured bark, with many stiff fibres on the upper part. The internal white fleshy substance abounds with a thick milky juice, which has a strong fetid smell resembling garlic. The stalk is round, smooth, striated from six to eight feet in height, and six or seven inches in circumference. The leaves are radical, six or seven in number, and nearly two feet in length, bipinnated, of a deep green colour and fetid smell. The flowers form an umbel, and produce oval seeds. The plant varies much according to the nature of the soil in which it grows, not only in the shape of the leaves but in the intensity of the odour of the juice. Sometimes this is so slight, that goats feed on the plant.

Assafœtida is collected from plants growing in the mountainous provinces of Chorassan and Loar in Persia. At the season of the year when the leaves begin to decay, the oldest plants are selected. First, the firm earth which encompasses the root is rendered light by digging, and part of it is cleared away so as to leave a portion of the upper part of the root above the ground; the leaves and stalk are then twisted off and used with other vegetables for a covering, to screen the root from the sun; and upon this covering a stone is placed, to keep the whole from being blown away. In this state the root is left for forty days, after which the covering is removed, and the top of the root is cut off transversely. It is then shaded from the sun for forty-eight hours more, which is thought a sufficient time for the juice to exude upon the cut surface of the root. The juice is then scraped off, and exposed to the sun to harden. A second transverse section of the root is again made, but no thicker than is necessary to remove the remaining superficial concretions which would otherwise obstruct the farther effusion of fresh juice. It is a second time shaded for forty-eight hours, and the juice scraped off as before. This process is repeated eight times on each root; after every third collection, ten days of an interval is allowed to elapse, in order to give the root sufficient time to secrete the juice. Thus from the first incision to the last, a period of five or six weeks is required; after this the root is abandoned, and it soon perishes. The whole of this process is conducted by the peasants who live in the neighbourhood of the mountains where the plants grow, and as they collect the juice from a number of roots at the same time, and expose it in one common place to harden, the sun soon gives it that consistence and appearance in which it is imported into Europe. Assafœtida has a bitter, acrid, pungent taste, and a powerful and peculiar fetid smell, the strength of which is the surest test of its genuineness. As this odour is very volatile, the gum loses much of its strength by keeping, and when recent the odour is much more powerful than after its transportation to Europe. It comes to us in large irregular masses, of a heterogeneous appearance, composed of various little lumps, or grains of a white brown, reddish, and violet colour. The best masses are those which are clear, reddish, and variegated with whitish tears. It is a gum resin, the smell and taste residing in the latter, which is readily dissolved in spirits, and to a considerable extent in water.

In medicine it is of very general use as a stimulant and antispasmodic in nervous affections; especially nervous affections of the stomach, combined with hysterical disease, flatulence, and colic pains. It is given in tincture, or emulsion, or in pills combined with aloes or colocynth. In some countries it is used as a condiment in food, in a similar way as garlic, which it in many respects resembles.

Inula or Elecampane (*inula helenium*). Natural family, *compositæ; syngenesia polygamia*,

201.

Elecampane.

of Linnæus. This plant is a native of England, and grows in moist meadows; it is also not unfrequently met with in the cottage garden. The root is perennial, large, thick, branched, externally brown and of a whitish gray within. The stalk is upright, strong, round, striated, hairy, and about

four feet in height. The leaves are large, ovate, serrated, crowded with a net-work of veins, with a strong fleshy mid-rib. The flower is very large and yellow. This plant is described as medicinal by Dioscorides and Pliny. The root is the part used; when dried and kept for some time it has a pleasant odour, like that of orris root. Its taste is aromatic, bitter, and pungent. It yields these qualities to spirits more readily than to water. Its virtues were much extolled by the older physicians; but it has not been found so deserving of praise in modern practice. Indeed, it is now fallen entirely into disuse. Its action, however, is similar to that of the other stimulating and aromatic bitters, and it is used in similar complaints; as in cases of weak digestion, hysterical and nervous complaints. One dram of the root in infusion, and from two to four drams in decoction, is said to be the dose usually given.

Florentine Orris Root *(iris florentina); triandria, monogynia.* This iris is a native of Italy, and flowers in June. It was cultivated in England, by Gerard, in 1590; and is now generally reared by florists as an ornament in the garden. The roots of those plants produced in this country, have not, however, the odour, or other qualities of those of warmer climates. The orris root of our shops is imported from Leghorn. The root in its recent state is extremely acrid; and when chewed excites a pungent heat in the mouth, which continues several hours. On drying this acrimony is almost wholly lost, the taste is slightly bitter, and the smell agreeable, resembling that of violets. On distillation it does not yield an essential oil; but the flavour is communicated to spirituous tinctures. The fresh root is a powerful purgative and emetic, and a dram of the juice for a dose has been employed in the cure of dropsies. The dry root is only used as an agreeable perfume, and is the ingredient which gives the peculiar flavour to artificial brandies made in this country.

Fenugreek. Natural family, *papilionaceæ; liadelphia, decandria,* of Linnæus. This is an

202.

Fenugreek.

annual plant, with an erect hairy stem about two feet high; the leaves are oblong, obtuse, and slightly serrated, and of a disagreeable smell. The flowers are white and appear in pairs; they are succeeded by a long compressed pointed pod containing numerous seeds of a round yellow colour. These seeds have a strong disagreeable smell, and an unctuous farinaceous taste, accompanied with a slight bitterness. These seeds are not now given as medicine internally, and are only rarely used as fomentations and cataplasms in indolent swellings, rheumatism, and ulcers, and sometimes in glysters. Formerly they were held in more esteem by medical men than they are now.

Valerian *(valeriana officinalis).* Natural family *valerianeæ; triandria, monogynia* of Lin-

203.

Valerian.

næus. This is a common plant about hedges and woods in Britain. The root is perennial, consisting of a number of simple fibres which unite at their origin; the stalk is upright, smooth, channelled, round, branched, and rises from three to four feet in height. The leaves in the stem are placed in pairs upon short broad sheaths, they are composed of several lance-shaped, partially dentated pinnæ with an odd one at the end, which is the largest. The radical leaves are much larger. The flowers are small, of a white or purplish colour, and terminate the stem in large branches. The flowers appear in June.

The narrow-leaved variety of this species, which does not exceed two feet in height, and grows on dry heaths, and elevated pastures, is in more repute than the other. Its roots manifest stronger sensible qualities, and consequently possess more active medicinal powers. Their odour is strong and peculiarly heavy, with a mixture of both aromatic and fetid qualities. The taste is warm, bitter, unpleasant, and slightly acrid.

Valerian is supposed to be the *phu* (expressive of its abominable smell) of Dioscorides and Galen, by whom it is extolled as an aromatic and diuretic. It was afterwards found to be useful in certain kinds of epilepsy arising from nervous irregularity; and, indeed, is now employed in many nervous affections arising from debility and irregular nervous action, or hysterical affections and convulsions.

A tea-spoonful of the powdered root, with a little cinnamon or mace, may be given twice or thrice a day. It also yields its virtues to spirit of wine and water, and a tea-spoonful or two of the tincture is also a common dose.

Cats are particularly fond of the odour of this root, and seem to be fascinated, as it were, when it is presented to them. It is said also that rats are equally attracted by its odour, and that rat-catchers employ it as a means of snaring these animals. This liking probably depends upon some sexual analogy of smell which the root presents to them.

Several of the species of this family of plants are cultivated as ornaments to the garden borders.

SASSAFRAS *(laurus sassafras)*. Natural family *lauridiæ; enneandria, monogynia*, of Linnæus. This plant resembles the laurel, to which family it belongs. It attains the height of twenty-five feet, and is above a foot in diameter, but in general it is of much less growth, and is divided towards the top into several crooked branches. The bark of the young shoots is smooth and green; of the old trunks it is rough and furrowed, and of a light ash colour. The leaves vary; some being oval, others divided into three lobes; they are of a pale green, downy on the under side, and placed alternately in long footstalks. The flowers are produced in pendent spikes or panicles, which spring from the extremities of the shoots of the preceding year. They appear in May and June, and are generally male and female upon different trees; the fruit is a berry like that of the cinnamon.

This tree is a native of North America, and appears to have been cultivated in England sometime before the year 1633; for in Johnston's edition of Gerard he says, "I have given the figure of a branch taken from a little sassafras tree which grew in the garden of Mr Welmot at Bon." It is said that this tree was first discovered by the Spaniards when they took possession of Florida, and the first import of the wood into Spain was about the year 1560, when it acquired great reputation for curing various diseases. It is now usually imported here in long straight pieces, very light, of a spongy texture, and covered with a rough fungous bark. It has a fragrant smell, and a sweetish, aromatic, subacid taste. The root, wood, and bark agree in their medicinal qualities, but the bark has most fragrance, and is thought to be more powerful than the wood. Distilled with spirits, a fragrant essential oil of a penetrating nature is procured, and so heavy as to sink in water. It yields its principles less completely to water, though a decoction of the wood is that frequently ordered. Its effects on the system seem to be slightly stimulant and sudorific, promoting the general secretions, but not showing much activity. Indeed it is now seldom used, except conjoined with other more active medicines in rheumatism, gout, and affections of the skin. A tincture is made by dissolving the bark and wood in rectified spirits, and in this way the whole properties of the plant are best obtained.

SARSAPARILLA *(smilax sarsaparilla)*. Natural family *sermentaceæ; diœcia, hexandria*, of Linnæus.

204.

Sarsaparilla.

This plant is a native of America, although another species, *s. aspera*, very similar in all respects, is common in the south of Europe.

The root is perennial, divided into several branches which are somewhat thicker than a goose quill, straight, externally brown, internally white, and three or four feet in length. The stalks are shrubby, long, trailing, and beset with spines. The leaves are oval and pointed. The flowers are male and female, on different plants. The calyx of both flowers is bell-shaped and six lobed. The fruit is a round, three-celled berry, containing two seeds. The root, which is the medicinal part, has a farinaceous, somewhat bitterish taste, and no smell. To water it communicates a reddish brown, to rectified spirits a yellowish red tincture, but imparts no taste to either. This root was introduced into Spain nearly three centuries ago, as an undoubted cure for syphilis and other diseases, as rheumatism and scrofula, and affections of the skin. Like many other remedies, however, its virtues in time came to be disputed, and it was for a time laid aside. Physicians are not even agreed in the present day about its effects, some asserting that its powers are considerable as an alterative and restorer of the system, especially after mercury has been administered, others holding it as entirely inert. The common mode in which the roots are used is as a decoction in water, either alone or joined with sassafras and guiacum.

GUIACUM *(G. officinalis); decandria, monogynia* of Linnæus. This tree is a native of South America, and the West Indian islands. It grows to the height of forty feet, and four to five feet in circumference sending off several large sub-

dividing knotty branches. The bark is dark gray, variegated with green or purplish spots on the trunk, but those of the branches are ash coloured. The roots are thick and large, and thick in proportion to the size of the tree, and run deep into the ground in a perpendicular direction. The leaves are pinnated, consisting of two, three, or four pairs of pinnæ. The flowers grow in clusters,the calyx is five-petalled,and of a blue colour.

The wood, gum, bark, fruit, and flowers, are all said to possess medicinal qualities. The wood is brought to Britain from Jamaica in large pieces of four or five hundred weight each; and from its hardness and beauty is in great demand for various articles of turnery ware; it is extremely compact, and so heavy as to sink in water. The outer part is of a pale yellow colour, the heart of a dark blackish brown, with a greater or less admixture of green. It has little smell except when heated, or when it is being rasped down, when it yields a slight aromatic odour. When chewed it discovers a slight acrimony. Its pungency resides in a resinous matter which dissolves readily in rectified spirit, and partially in boiling water. This gum or gummy resin is obtained by wounding the bark in different parts of the tree, which is termed *jagging*. The gum flows gradually, but plentifully from those wounds, and hardens in the sun, when it is scraped off and packed in small kegs for exportation. This resin is of a friable texture, of a deep greenish colour, and sometimes of a reddish hue. It has a pungent acrid taste, but little or no smell unless when heated. This tree yields a spontaneous exudation from the bark, which is called the native gum, and is brought to this country in small irregular pieces, of a bright semi-pellucid appearance, and differs from the other gum in being much purer. The bark contains less resinous matter than the wood, and is consequently a less powerful medicine, though in a recent state it is strongly purgative. The fruit is said to be purgative also, and in medicinal qualities far excels the bark. The flowers are laxative, and in Jamaica are commonly given to children in the form of a syrup, which in appearance resembles that of syrup of violets. But the wood and resin alone are employed in Europe. Guiacum, like the resins and balsams, is a stimulant of a very diffusible nature in the human system, and affects the skin, urinary organs, and intestines very readily. Hence perhaps its use in rheumatism and similar affections, and also in diseases of the skin. It is used in decoction along with the other woods just described, as also in tincture when its active parts are most perfectly preserved. The only objection is the amount of spirits which is combined in the tincture, and this in many cases may be a serious objection.

Snake root, Birth Wort *(aristolochia serpentaria) gynandria, hexandria*, of Linnæus. This plant is a native of Virginia, North America, where there are several species nearly allied. There are also several European species. The root is perennial, and composed of a number of small fibres proceeding from a common trunk, externally brown, and internally whitish. The stems are slender, round, crooked, jointed, and eight to ten inches high. The leaves are heart-shaped, entire, pointed, and stand upon long footstalks. The flowers are monopetallous, solitary, and of a purple colour; the corolla is tubular and twisted. The root is the medicinal part. It has an aromatic smell, approaching to that of valerian, but more agreeable, and a warm, bitterish, pungent taste, which is not easily concealed by other mixtures. It imparts its active matter both to water and spirits, and yields, by distillation, an essential oil.

This root was first extolled as a cure for the bite of the rattle snake, and other serpents, and hence its name. It was also said that the snake charmers used the juice of this root to stupify the snakes as preparatory to taming them. It is, however, extremely doubtful whether it possesses either the power of charming snakes or curing their bites. Equally apocryphal are its reported cures of malignant fevers; and modern physicians are contented to employ it as a tonic, and aromatic stimulant.

The powdered root is given to the extent of ten or thirty grains, and in tincture one or two tea-spoonfuls. Its employment, however, is now much less practised than formerly.

The long rooted Birth Wort (a. longa) and other two species, the round and slender, are European plants, whose roots possess similar properties to the American snake root. These were employed by the ancient physicians, and by them esteemed in affections of the uterus.

The celebrated Portland powder for the cure of gout contained the roots of aristolochia, along with gentian, centaury, and some other bitters; a dram of this mixture was directed to be taken every morning for three months, and in gradually diminished doses afterwards for a year or more. This powder had in many cases the effect of warding off attacks of gout, but its long continued use injured the stomach and nervous system, and brought on premature decay and death.

The Rose *(rosa canina, r. centifolia, r. gallica). Icosandria, polygynia*, of Linnæus. The hip or dog rose, is the common wild species from which the garden roses are produced. It is a shrub rising to six or ten feet in height, with smooth bark, beset with alternate, hooked prickles. The flowers are large, and composed of five flesh-coloured, or white petals. The capsule containing the seeds or hip, is of a

subacid, pleasant flavour, and is formed with sugar into a preserve.

Two varieties, the hundred-leaved, and red or common rose, are used in medicine. The hundred-leaved is so called from the number of its petals, which are of a pale red or flesh colour. The red rose has larger and finer petals, and is of a deep crimson colour. The leaves of the latter are generally collected and dried, and are used for making the infusion of roses; they are more astringent than the former, but have less odour. An essential oil is obtained from the distillation of rose leaves, which possesses all the concentrated and delightful odour of the rose. It is well known under the name of attar, or oil of roses. It is chiefly made in India, where the rose grows in abundance.

To produce this oil, forty pounds of the rose flowers, with their calyces, are put into a rude still with sixty pounds of water. The mass being well mixed, a gentle fire is put under the still; and when fumes begin to rise, the cap and pipe are properly fixed and luted. When the impregnated water begins to come over, the fire is lessened by gentle degrees, and the distillation is continued until thirty pounds of water are come over, which generally takes place in about four or five hours. This water is to be poured upon forty pounds of fresh roses, and thence are to be drawn from fifteen to twenty pounds of distilled water by the same process as before. It is then poured into pans of earthen ware, or of tinned metal, and left exposed to the fresh air for a night; the attar or essence will be found in the morning congealed, and swimming on the top of the water. It is then skimmed off, carefully freed from any remaining drops of water, and then put into bottles for sale.

A conserve with honey or sugar is made of the fresh petals of the hundred-leaved rose, which is found a mild and pleasant laxative, and may also be employed in making infusion of roses, by pouring on an ounce of the conserve one pound of water. The addition of a few drops of diluted sulphuric acid, heightens the colour and improves the astringent effect of this infusion. It may be used internally in spitting of blood, or as a gargle in affections of the throat.

CHAP. XLIX.

THE ALOE, SCAMMONY, JALAP, COLOCYNTH, &c.

In the preceding chapter we have described those plants which are possessed of a bitter and astringent principle, joined sometimes with an aromatic flavour. We now proceed to consider those plants whose juices have an action on the stomach and intestinal canal, called purgative; in other words, which have a peculiar stimulating property on those organs, by which their natural or *peristaltic* motion is increased, as also the secretions from their surface.

The Aloe *(aloe socotrina)*. Natural family *hemerocalledeæ; hexandria, monogynia*, of Linnæus. Of this genus there are at least 150 species and varieties. The greater part of which are natives of Africa, and a few of the East and West Indies.

205.

Aloes.

There are several species or varieties supposed to yield the gum aloes, and known in commerce, namely, *a. Socotrina* (from Socotra), *vulgaris* (Barbadoes), *spicata* (Cape), *Indica*, two or three varieties. About 120 to 130 tons of aloes are annually imported.

The root of the socotrine aloe is perennial, strong, and fibrous; the flower stems rise three or four feet in height, and are smooth, of a shining green colour, and towards the top beset with bracteal scales. The leaves are numerous, and proceed from the upper part of the root; they are narrow, tapering, thick or fleshy, succulent, smooth, shining, and beset at the edges with spiney teeth. The flowers are produced in terminal spikes; there is no calyx; the corolla is tubular, divided into six narrow segments at the mouth, and of a striped purplish colour. The capsule contains numerous angular seeds. It is a native of the Cape of Good Hope, and the island of Socotra. It flowers most part of the year, and must not be confounded with another plant, the American aloe *(agave Americana)*, which is remarkable for the long interval between the periods of its inflorescence.

A tract of mountains about fifty miles from the Cape of Good Hope, is wholly covered with the aloe plant, which renders the planting of them there unnecessary; but in Jamaica and Barbadoes they are carefully cultivated. To the former of these islands they were first brought from Bermuda, and gradually propagated themselves. They require two or three years standing before they yield their juice in perfection, to procure which, the labourers go into the field with tubs and knives, and cut off the largest and most

succulent leaves close to the stalk; these are immediately put into the tubs and disposed one by the side of another in an upright position, that all the loose liquor may flow out at the wound. When this is thought to be almost wholly discharged, the leaves are taken out one by one, passed through the hand to clear off any part of the juice that may yet adhere or stick in the less open veins; and the drained liquor is put into shallow flat-bottomed vessels, and dried gradually in the sun until it acquires a proper consistence. What is obtained in this manner is generally called *socotrine aloes*, and is the clearest and most transparent, as well as the highest in esteem and value.* The method of procuring the common aloes in Barbadoes is thus described by Millington.† After a quantity of juice is drained from the leaves, it is carried to the boiling house. One, two, or three iron or copper boilers, are placed on the fire and filled with juice. As the boiling goes on and the fluid becomes thicker by evaporation, it is ladled forward from boiler to boiler; and fresh juice is added to the first boiler as it is gradually emptied. When the juice in the third boiler, which is the smallest, has arrived at a proper degree of consistency, it is ladled out into gourds; and this is known by dipping in a small piece of wood, allowing the matter to cool, and then observing whether the resin cuts freely, or comes away in thin flakes from the stick. A little lime water is used by some aloe boilers during the process, when the ebullition is too great. The sun-dried resin, which is a tedious process, is seldom made in Barbadoes. Dr Wright gives a somewhat different account of the manufacture of aloes. According to him the plant is pulled up by the roots, and carefully cleansed from earth or other impurities. It is then sliced and cut in pieces, and put into small hand baskets or nets; these are put into large iron boilers with water, and boiled for ten minutes, when they are taken out and fresh parcels supplied, till the fluid becomes strong and black. At this period the liquor is thrown through a strainer into a deep vat, narrow at bottom, and left till it cools, and deposits its feculent parts. Next day the clear liquor is drawn off by a cock, and again committed to the large iron vessel. At first it is boiled briskly, but towards the end the evaporation is slow, and requires constantly stirring to prevent burning. When it becomes of the consistence of honey, it is poured into gourds or calabashes for sale.

The socotrine aloe was formerly procured from the island Socotra, or Zocotra, at the mouth of the red sea. It comes wrapt in skins, and is of a bright glossy surface, in the lump, of a yellowish red colour, with a tinge of purple; when reduced into powder it is a golden yellow. Its consistency alters with heat and cold. Its bitter taste is accompanied by an aromatic flavour, but not sufficient to prevent its being disagreeable. The smell is not very unpleasant, and sometimes resembles that of myrrh. The hepatic aloes are chiefly brought from Barbadoes; the best sort in large gourd shells, the inferior kind in pots, and a still worse in casks; it is of a darker colour, and not so clear as the other. It is generally drier and more compact, though sometimes the inferior sort is soft and clammy. Its smell is much stronger, and more disagreeable; the taste intensely bitter and nauseous, with little aromatic flavour.

The *Horse Aloe* is easily distinguished from both the foregoing, by its strong rank smell. In other respects it resembles the hepatic, and is sometimes as clear and bright as the socotrine, only its smell is disagreeable, and devoid of all aromatic odour. This kind, as the name implies, is used chiefly by Farriers.

Aloes consists of a resin and gummy matter united. It readily dissolves in proof spirits, and in hot water, but not so perfectly. The hepatic contains more resin and less gum than the socotrine, and on the gum its active principle depends.

It is a universal and well known purgative, and forms the principal part of most aperient pills. It is thought to act chiefly on the lower and larger intestines, and is not so frequently given alone as in conjunction with rhubarb, colocynth, and scammony. It will in many cases act in the quantity of three or four grains, in others, from twenty to thirty grains is a usual dose.

This drug was known to the ancients, and employed by Dioscorides, Celsus, and Avicenna, although it is not mentioned by Hippocrates.

It is one of the safest and best warm and stimulating purgatives to persons of sedentary habits, and phlegmatic constitutions.

COLOCYNTH *(cucumis colocynthis)*. Natural family *cucurbitaceæ; monœcia, syngenesia*, of Linnæus. This is one of the gourd family, and is common in Turkey; although it is not well ascertained in what country it is indigenous. It is an annual trailing and climbing plant, like the garden cucumber. The leaves are triangular, obtusely notched, hairy, green on the upper surface, and light-coloured, and rough on the under. The flowers are small, solitary, and of a yellow colour. The fruit is a round gourd, about the size of an orange, divided into three cells, abounding with a pulpy matter, and containing numerous oval, compressed seeds. It seems to have been cultivated in Britain in the time of Turner; but in our hot-houses its fruit is rarely developed. The spongy medullary part of the fruit is that which possesses medicinal activity; it is nauseous, acrid, and intensely

* Brown's Jamaica. † Hist. of Barbadoes.

bitter. A decoction of this pulp in water, and then evaporated, forms the extract of colocynth

206.

Colocynth.

used in medicine. The pulp is very bitter; hence the terms *bitter apple*, *devil's apple*, &c., by which it is popularly known. This very powerful purgative is the *kolokunthis* of the ancient Greeks, and the *alhandat* of the Arabian physicians. It was frequently used by both in different diseases, though not without an apprehension of danger from the violence of its effects, of which various instances are related. In doses of ten to twelve grains, it acts vehemently on the intestines, frequently producing violent gripes. The best method of abating its violence without diminishing its purgative effect, is to triturate it with gummy, farinaceous substances, or oily seeds, and form it into an emulsion.

In the proportion of one or two grains, it may be combined with aloes or rhubarb, and forms a safe and excellent pill in all cases where the bowels and constitution are of an indolent nature. The seeds are perfectly bland, and highly nutritious; and in northern Africa are used by the natives as a common article of food.

Scammony *(convolvulus scammonia)*. Natural family *convolvulaceæ; pentandria, monogynia*, of

207.

Scammony.

Linnæus. This plant grows in abundance about Maarash, Antioch, Edlib, and towards Tripoli, in Syria; and was first introduced into England by Gerard, in 1597. The root is from three to four feet in length, and from nine to twelve inches in circumference, covered with bark of a light gray colour. It is perennial, tapering, branched towards the bottom, and contains a milky juice. The stalks are numerous, slender, twining, and spread themselves upon the ground or neighbouring trees, to the extent of fifteen or twenty feet. The leaves are arrow-shaped, smooth, of a bright green colour, and stand upon long footstalks. The flowers are funnel-shaped, yellow plicated, and placed in pairs upon the pedicles. The capsule is multilocular, and contains seeds of a pyramidical shape.

It is from the milky juice of the root that the scammony of medicine is procured, no other part of the plant possessing any active qualities. The mode of procuring the juice is as follows: The peasantry having cleared away the earth from about the root, they cut off the top in an oblique direction about two inches below where the stalks spring from it. Under the most depending part of the slope, they fix a shell or some other convenient receptacle, into which the milky juice gradually flows. It is left there about twelve hours, which time is sufficient for drawing off the whole juice. This, however, is in small quantity, each root affording but a very few drams. The juice from the several roots is put together, often into the leg of an old boot for want of some more proper vessel, where, in a little time, it grows hard, and forms the genuine scammony.* It is a green resin, generally of a light, shining gray colour, and friable texture. It is brought from Aleppo and Smyrna; that which comes from the latter place is less valued than the former, and is supposed to be more ponderous, and of a deeper colour; but the colour affords no test of the goodness of this drug, which seems to depend entirely upon the purity of the concrete juice. The smell is rather unpleasant, and the taste bitterish, and slightly acrid. The different proportions of gum and resin, of which it consists, have been variously stated; but as it dissolves entirely in proof spirits, this shows that the two substances must be in nearly equal proportions.

Scammony was well known to the Greek and Arabian physicians, and was not only employed internally as a purgative, but also as an external remedy for tumours and diseases of the skin. In small doses of two or three grains, it may be given alone; but it is more frequently used combined with other purgatives, as aloes and colocynth.

Jalap *(convolvolus jalapa)*. This is another plant of the genus ipomæ, nearly allied to the former. It is a native of Xalapa, in Mexico, hence probably its name. The root is perennial, large, heavy, of an irregular oval form, black

* Dr Russel.

colour, and abounding in a milky juice. The stalks are numerous, shrubby, slender, striated,

208.

Jalap.

twisted, and climb for support to other bodies, rising to twelve feet in height. The leaves vary in form, but are generally heart-shaped; they are smooth, of a bright green colour, and stand alternately upon long footstalks. The flowers are large, bell-shaped, entire, and plicated, of a reddish colour externally, but a purple within. The flowers appear in August and September. It is said that the root of Jalap was first brought to Europe about the year 1610. It is now one of the most common purgatives. The root has little smell or taste, but imparts a slight degree of pungency in the mouth. Its medicinal activity resides in the resinous matter of the root. It is found to be a safe and efficacious purgative, when given in doses of twenty to thirty grains of the powdered root. The root requires to be well pounded, so as to separate the resinous particles, and for this purpose crystals of tartrate of potass are often added.

It may also be dissolved in proof spirits, and administered in tincture, either alone or conjoined with senna or aloes.

Buckthorn *(rhamnus catharticus.)* Natural family, *rhamni; pentandria, monogynia*, of Linnæus. This shrub is a native of Britain, and usually is to be found in woods and hedges near running streams. The stem is covered with dark brown bark, and divides into many branches beset with strong spines. Its height is seven or eight feet. The leaves are elliptical, serrated, and stand on short footstalks. The flowers are commonly male and female on different plants. There is no corolla; the calyx is of a greenish yellow colour, divided at the extremity into four segments. The fruit is a round black berry, containing four seeds. It flowers in May or June, and the seeds are ripe about the end of September.

The berries, which are the medicinal part of the shrub, contain a pulpy deep green juice, which has a faint unpleasant smell and a bitter acrid taste. Twenty of the fresh berries produce a purgative effect, with heat and thirst, and often severe griping. The expressed juice and powder of the dried berries have also similar effects. A syrup is made of the expressed juice and sugar. Though a powerful purgative, and useful in dropsies and obstinate costiveness of habit, it is now seldom used in modern practice, on account of the violence of its effects. The inner bark is also of a purgative nature.

The juice of the unripe berries stains paper of a saffron yellow. The juice of the ripe berries, mixed with alum, forms the sap green of artists. If the berries be allowed to get over ripe, their juice produces a purple colour; the bark yields a beautiful yellow dye.

209.

Senna.

Senna *(cassia Egyptiaca)*. Natural family, *leguminosæ; decandria, monogynia*, of Linnæus. This plant is an annual; the stalk is strong, smooth, branched, and rises to the height of about two feet. The leaves are alternate, with narrow pointed stipulæ at the base. Each leaf is composed of several pairs of oval or elliptical pointed nerved sessile pinnæ, of a yellowish green colour. The flowers are yellow, and produced successively in long axillary spikes. They appear in July and August. The seeds are contained in a compressed curved pod. This plant is a native of Egypt, it also grows in some parts of Arabia, especially about Mocha; but as Alexandria has ever been the great mart from which it has been exported into Europe, it has long been known under the name of Alexandria senna, or sena. Hassilquist found this plant growing spontaneously in Upper Egypt. The blunt leaved senna, *S. natica*, is a variety of the sea species, which by its cultivation in the south of France has been

found to assume this change. It is less purgative than the pointed leaved senna, and requires therefore to be given in larger doses. It was employed by Dr Wright in Jamaica, where it grows on the sand banks near the sea.

Senna appears to have been cultivated in England in the time of Parkinson, about the year 1640, and Miller says that by keeping these plants in a hot bed all the summer, they frequently flowered; but they rarely perfect their seeds in this country. There is little doubt, however, but that senna might be cultivated in some parts of the British colonies in sufficient quantity to supply our wants. The dried senna leaves imported to this country and in common use, have a slightly unpleasant smell and a bitterish nauseous taste. They impart these virtues both to water and proof spirit. The most common mode of using them is in an infusion, by pouring boiling water on the leaves. They should not, however, be subjected to the boiling process, as this dissipates certain volatile parts of the leaves in which their active powers mainly depend.

Senna was first brought into use by the Arabian physicians Serapion and Mesue, and Achiarius is the first of the Greeks by whom it is noticed, who, however, does not recommend the leaves but the fruit. Mesue likewise seems to prefer the pod to the leaves, as being more powerful, but this is not the case, its purgative quality being certainly less powerful, although it does not cause griping as the leaves sometimes do. An infusion of senna, combined with bitter infusion, as gentian or centaury, has its purgative qualities increased. The 'black draught,' so much in use among medical practitioners, is a combination of senna and gentian, with the addition of any aromatic, as cardamom or coriander seeds, or the rind of the Seville orange. A strong infusion of senna gripes more than a weaker one; the proper proportion is one dram of senna to four ounces of water.

The common bladder Senna, (Coluntea arborescens,) a shrub cultivated in gardens for ornament, and which grows spontaneously on the sides of mount Vesuvius, also possesses a purgative quality similar to senna, though in an inferior degree. A double quantity of the leaves of this plant may be substituted for the common senna, with similar results. A dram or two of the seeds excite vomiting. Haller and Ray mention that cattle feed readily on the leaves and twigs of this plant.

Purging Cassia *(cassia fistula)*. This is a tree belonging to the same natural family, which attains the height of forty feet; producing many spreading branches towards the top, and covered with brownish bark, intersected with many cracks and furrows. The leaves are composed of four or six pairs of pinnæ, which are ovate, pointed, and of a pale green colour. The flowers are large, yellow, and placed in spikes upon long peduncles. The pods are cylindrical, pendulous, and from one to two feet in length; they contain numerous hard, compressed seeds, surrounded by a black pulpy matter.

This tree is a native of Egypt, and of the East and West Indies. It was first introduced into England by Miller, in 1731. The pods of the East India cassia, are of less diameter, smoother, and afford a blacker, sweeter, and more grateful pulp, than those which are brought from the West Indies, South America, or Egypt; and are universally preferred. In Egypt, it is the practice to pluck the cassia pods before they arrive at a state of maturity, and to place them in a house from which the external air is excluded as much as possible; the pods are then laid in strata of half a foot in depth, between which palm leaves are interposed: the two following days the whole is sprinkled with water, in order to promote its fermentation; and the fruit is suffered to remain in this situation forty days, when it is sufficiently prepared for keeping. Those pods which are the heaviest, and in which the seeds do not rattle on being shaken, are commonly the best, and contain the most pulp, which is the part employed in medicine.

The best pulp is of a shining black colour, and of a sweet taste, with a slight degree of acidity. It is doubtful whether this substance was employed by the ancient Greeks; and it seems first to have been brought into notice by the Arabian physicians. This pulp has been long used as a gentle and mild laxative to children and delicate persons; its operation, however, is so gentle, as in most cases to require the aid of other stronger medicines. An electuary or compound, has therefore long been in use, called "lenetive electuary." Perhaps, however, a cheaper, and as effectual substitute for the cassia pulp, is to be found in the common damson preserve.

Castor Oil Plant *(ricinus communis*, or *palma christi)*. Natural family *euphorbiaceæ; monœcia, monadelphia*, of Linnæus. This plant, though an annual, and herbaceous in our gardens, becomes a tree in Africa of several years' standing. In Candia it continues many years; and, according to Belon, requires a ladder to come at the seeds. The root is long, thick, whitish, and sends off many small fibres. The stem is round, thick, jointed, shining, of a purplish red colour towards the top: and rises luxuriantly in this country to six or ten feet, in warm climates to fifteen and twenty feet in height. The leaves are large, and deeply divided into seven lobes, or pointed, serrated segments; and are of a bluish green colour. The flowers are male and female on the same plant, and are produced on a clustered, terminal spike. The male flowers have no corolla. and are placed on the under part of

the spike; the female flowers occupy the upper part, and have the calyx cut into three narrow segments, of a reddish colour. The capsule is a large, three-celled nut, covered with tough spines and contains three flattish, oblong seeds, which are forced out on the bursting of the capsule. It flowers in July and August.

This plant was most probably familiar to the ancients, for it is conjectured to be the *kiki* or *croton*, of Dioscorides, who describes the seeds as powerfully cathartic. It is also mentioned as a rather violent and irritating cathartic by Etius, Paulus Ægineta, and Pliny; and most probably obtained this character from giving the bruised seeds along with the membranes, which latter produce a griping, irritating effect.

This plant was first introduced into England in 1562, in the time of Turner; and is now common border plant in gardens, where it often attains the height of ten feet, and forms a splendid ornamental flower. For this purpose it requires to be sown in pots early in the season, kept in the hot-house for some time, and then transplanted into light rich soil.

The oil is obtained from the seeds by expression, in a similar way as that already described in obtaining the other vegetable oils.

The oil obtained without heat, or the "cold drawn," is the purest, and has little or no colour It is a clear, limpid, almost tasteless, and odourless fluid, not liable to become rancid. The oil obtained by heating, or parching the seeds, has more colour, but according to the opinion of some is more bland, and less liable to gripe than the other. The manner of obtaining the oil in Jamaica is as follows: The seeds being freed from the husks or pods, which are gathered upon their turning brown, and when beginning to burst open, are first bruised in a mortar, afterwards tied up in a linen bag, and then thrown into a large pot with a sufficient quantity of water, about eight gallons to one of the seeds; and then boiled till the oil has risen to the surface, when it is carefully skimmed off, strained, and kept for use. In Jamaica, besides its medical use, it is employed for lamps and other domestic uses.

In doses of half an ounce to an ounce, it forms a mild, safe, and quickly operating purgative. The addition of a small portion of spirits takes away its nauseating effects, and makes it more agreeable to the stomach. Unlike almost all other purgatives, its frequent use has the effect of enabling the patient to diminish, instead of to increase the dose. It may also be used as an enema; and joined with equal parts of oil of turpentine, is the most efficacious cure for worms.

CROTON *(croton tiglium)*. Natural family *euphorbiaceæ; monœcia, monodelphia*, of Linnæus. This shrub, which is a native of the East Indies, produces the seed from which the oil of croton is procured. This oil is so irritating, that a

210.

Castor Oil Plant.

single drop of it applied to the tongue, produces an effect on the whole alimentary canal. It is given in severe and obstinate cases of costiveness, in doses of from one to two drops, made up with oil of almonds, or mucilage of gum Arabic and sugar. It is also applied combined with any bland oil, as an external irritant to the skin.

The *Cascarilla Croton (c. eleutherium)*, another shrub of this family, affords a bitter aromatic bark, which is not unfrequently used in medicine.

Some of the other species of the same genus are used as dyes, and have already been alluded to.

RHUBARB *(rheum palmatum)*. Natural family *polygoneæ; enneandria, trigynia*, of Linnæus. There are at least half a dozen species of rhubarb, the roots of all of which possess medicinal properties; the *palmatum*, however, is that which yields the rhubarb of commerce. The root is perennial, thick, of an oval shape, and sends off long tapering branches; externally it is brown, and internally of a deep yellow colour. The stalk is erect, round, hollow, jointed, sheathed, and rises to the height of six or eight feet. The radical leaves are numerous, large, rough, of a roundish figure, and deeply cut into lobes, and irregularly pointed segments. The stalk leaves spring from the joints, which they supply with membranous sheaths. The flowers terminate the branches in numerous clusters, forming a kind of spike, and appear in April or May. The corolla divides into six obtuse segments, which are of a greenish white colour. This species is a native of Tartary.

It was not till the year 1732, that naturalists became acquainted with the plant which seemed to afford the officinal rhubarb; when some plants received from Russia by Jussieu, at Paris, and

Rand, at Chelsea, were said to supply this important desideratum.

As some doubts still remained, Boerhaave procured from a Turkish merchant the seeds of those plants whose roots he annually sold. These seeds were soon propagated, and were discovered to produce two distinct species, the *r. undulatum*, and *r. palmatum*. Previous to this time Dr Gorter had repeatedly sent its seeds to Linnæus, but the young plants which they produced constantly perished; at length he obtained the fresh root, which succeeded very well at Upsal, and afterwards enabled the younger Linnæus to describe this plant in 1767.

Two years before this, Dr Hope had read before the Royal Society of London, an account of a plant of the *r. palmatum*, which grew in the Botanic garden at Edinburgh. "From the perfect similarity of this root," says Dr Hope, "with the best foreign rhubarb, in taste, smell, colour, and purgative qualities, we cannot doubt of our being at last possessed of the plant which produces the true rhubarb; and may reasonably entertain the agreeable expectations of its proving a very important acquisition to Britain." Since that period this species, as well as several others, have been cultivated with success in this country. But owing to the prejudice in favour of foreign roots, the demand for the home growth has not been such as to encourage its farther cultivation. The only deficiency was in the digging of the root, but this might easily be improved. Its cultivation is easy. It is sown in spring, in a light soil, and transplanted next spring into a similar soil well trenched, the plants being sèt at a yard distance from each other each way. The third year some plants begin to flower; but the roots are not lifted till the autumn of the sixth year. When dug out of the ground, they are first to be washed in a large quantity of water; and after the fibres and small roots are cut off, they are well brushed in fresh water, and cut into pieces of a proper size. The brown bark is then washed off, and they are again thrown into fresh water for three or four hours, in which they give out a great quantity of gummy matter. They are then taken out and laid upon twigs to drip till next morning; and it is chiefly in this time that they exude at every part, a white, transparent, gummy matter, resembling jelly. They are lastly placed in a stove, heated to 120° or 140°, till they dry. Twenty-five pounds of the recent root, yield only about eight pounds of the dry. It is not, however, yet fit for sale. All the wrinkles must be rasped and filed out, and the pieces thus dressed put in a barrel fixed on an axis, and rolled about in it for twenty minutes or half an hour, when they get covered by a fine powder formed by their rubbing against each other. Prepared in this way, it may be powdered, and has in every respect the appearance of foreign rhubarb. The chief peculiarity in this process is the steeping the roots in water, to extract the gummy or mucilaginous matter; without this precaution, according to Baume, the root cannot be reduced to powder, even when perfectly dry, but becomes pasty under the pistil. British rhubarb is cultivated in considerable quantities in the neighbourhood of Edinburgh, and sold at nearly the price of foreign rhubarb. It is easily reduced to a very fine powder, although it is merely washed and peeled, before it be cut into proper pieces, and dried upon the top of a baker's oven.

There are two sorts of rhubarb imported into this country, Chinese and Turkey rhubarb, differing in quality, although they both come from the same country. All the rhubarb of commerce is brought from the Chinese town, Sini, or Selim, by the Bucharians. It grows on the neighbouring chain of lofty mountains, which stretches to the lake Kokonor, near the source of the river Chorico. It is dug up by the peasants, cleared from the earth, cut into pieces, strung with the bark on strings, and exposed to dry under cover in the shade for a whole year, when it is again cleansed and prepared for exportation. In Kiachta, on the Russian frontier, it is received from the Bucharians by a Russian apothecary, who examines it; the bad is immediately burnt, and the good is freed from its bark, woody parts, and every impurity in the most careful manner. It is then sent to Moscow and Petersburgh, where it undergoes a second examination. This forms the Russian or Turkey rhubarb, which is reckoned the best. It is commonly in round pieces, of a reddish or whitish-yellow colour, feels gritty between the teeth; and is often perforated with so large a hole, that many pieces have the appearance of a mere rind. The Chinese or East India rhubarb, is brought by sea from Canton, and is heavier, harder, and more compact, than the other; seldom perforated with holes, and is either in long pieces or with two flat sides, as if they had been compressed. The general characters of good rhubarb are, its having a whitish or clear yellow colour, being dry, solid, and compact; moderately heavy, brittle; where recently broken appearing marked with yellow or reddish veins, mixed with white, being easily pulverizable; forming a powder of a fine bright yellow, having the peculiar, nauseous, aromatic smell of rhubarb, and a subacrid, bitterish, somewhat astringent taste, and when chewed feeling gritty under the teeth; speedily colouring the saliva, and not appearing very mucilaginous. Rhubarb contains a large proportion of bitter extractive matter, soluble in water and spirits; and also an aromatic, odorous matter, on which its activity as a purgative depends.

Rhubarb acts as a mild purgative, and as a tonic and astringent. It may be given in powder, in doses of a tea-spoonful, or in infusion in water, or as a tincture dissolved in spirits. It is found to yield more of its purgative quality to water than to alchohol.

In habitual costiveness it is not an appropriate medicine, as its astringency tends to keep up this state of the bowels. In stomachic affections, and laxity of the intestines, it is, however, highly useful; and on this account is a common remedy in diarrhæa, or looseness of the bowels, either alone or given with some absorbent substance, as magnesia or chalk.

We have elsewhere alluded to rhubarb as furnishing from its stalks a pleasant and salutary acid substance, which is made into tarts. The Persians have for a long period been in the habit of using this substance for the same purpose.

Gamboge. This substance is obtained from the juice of a tree which grows in Siam and Ceylon, belonging to the natural family *tricoceæ; polygamia, monœcia*, of Linnæus. This tree is of a middling size; and the leaves and young shoots when cut, yield a juice which soon concretes into a yellow resin.

A similar substance is also obtained from various species of garcinia and hypericum. This gum is brought from India in large cakes or rolls. The best sort has a deep yellow or orange colour, shining fracture, and is free from irregularities. It has no smell, and very little taste, unless kept in the mouth for some time, when it imparts a slight sense of acrimony. It is a most active purgative, both upwards and downwards, in doses of from two to six grains. In cases of tapeworm, it has been given in doses of fifteen grains, combined with fifteen grains of vegetable alkali. In general, it is exhibited in small quantity, along with aloes or other purgatives, in the form of pills. It requires to be administered with caution.

It forms an active ingredient in "Morrison's pills." It is also an ingredient in most of the nostrums for the cure of tapeworm.

Ipecacuan. It is somewhat singular that the real plant from which this well known emetic powder is obtained, has not yet been accurately ascertained. It has been referred to several different genera, as *euphorbia, lonicera, viola*, and *physcotria*. The annexed cut is a figure of the true ipecacuan plant, but without the inflorescence; the original of which was sent to the late Joseph Banks by governor Philip, from Brazil.

There are three sorts of ipecacuan root commonly brought to this country, chiefly distinguished by the colours of ash gray, brown, and white. The ash coloured is brought from Peru, and is a small wrinkled root, bent, and contorted into a great variety of figures; brought over in short pieces full of wrinkles and deep circular fissures, down to a small white, woody fibre,

211.

Ipecacuan.

that runs in the middle of each piece. The bark is compact, brittle, looks smooth, and resinous, upon breaking it has very little smell; the taste is bitterish, a little acrid, and slightly mucilaginous.

The brown is small, somewhat more wrinkled than the foregoing, of a brown or blackish colour without, and white within. This comes from Brazil. The white sort is woody, has no wrinkles, and no perceptible bitterness in taste. The ash coloured is that generally preferred for medical use. The brown has been sometimes observed, even in a small dose, to produce violent effects. The white is of a weak action. According to Dr Irving, the root contains a resin and gum, the latter being more powerfully emetic than the former, and also existing in greater quantity. The bark is stronger than the woody part, and the whole root is antiseptic and astringent. Vinegar has the power of destroying the emetic quality of the root; thirty grains of the powder given in acetous acid, only produces a laxative effect on the bowels.

Piso gives the first account of ipecacuan in 1649; and about thirty years after this period it was introduced into general practice in France, by Kelvetius. In doses of fifteen to twenty-five grains, it forms one of the safest and most effectual of emetics; in smaller quantities, it is employed as a sudorific; and in all those cases where the increased action of the vessels of the skin is deemed useful. Combined with opium, it forms the celebrated sweating medicine called *Dover's powder*.

Squill *(scilla maritima)*. Natural family *asphodeliæ; hexandria, monogynia*, of Linnæus. This is a perennial, herbaceous plant, with a large bulbous root, coated like the common onion, of a reddish colour, and abounding in a thick juice. The stem is round, smooth, succulent, and is from two to three feet in height. The leaves spring from the root, and are long, sword-shaped, and pointed. The flowers are produced in a long close spike, and have six

whitish coloured petals. They appear in April and May. The capsule is oblong, and contains numerous rounded seeds.

212.

Squill.

This plant is a native of Spain, Sicily, and Syria, where it grows in sandy situations on the sea coast.

It was first cultivated in England in 1648, in the Oxford botanic garden. The red rooted variety has been supposed to possess greater strength than the white, and is preferred for medical use. The root has little smell, but to the taste is very nauseous, and intensely bitter and acrimonious. It imparts its virtues to both spirits, vinegar, and water.

This root was known to the ancient Greeks, and has ever since been employed by physicians. In large doses it proves poisonous to many animals; and in man excites violent action of the stomach, intestines, kidneys, and bladder. In moderate doses, however, of a few grains, it is a perfectly safe and efficacious medicine, and is used in coughs, asthma, and dropsy. To prevent its too great action on the stomach, it is frequently combined with a portion of opium. With calomel it forms a powerful stimulant of the urinary organs.

The root to be preserved should be slowly dried, but not overmuch, and then reduced to powder. It may be given in doses of from two to five grains in this way, or as a tincture in spirits or vinegar.

White Hellebore *(veratrum album)*. Natural family *liliaceæ; polygamia, monœcia*, of Linnæus.

213.

Hellebore.

The root is perennial, about an inch thick, with numerous strong fibres. The stalk is thick, strong, round, hairy, and about four feet high. The leaves are large, oval, ribbed, plaited, and of a yellowish green colour. The corolla is six-petalled. The flowers are both hermaphrodite and male.

This plant is a native of Italy, Switzerland, Austria, and Russia. Gerard is supposed to be the first who introduced it into Britain, about the year 1596.

Two kinds of hellebore, the white and the black, were held in much esteem by the ancients, although it is difficult exactly to trace which kind is described by Dioscorides. Hippocrates frequently mentions hellebore, simply or generally, by which we are told the white is to be understood, as he adds, the words black, or purging when the other species is meant; and as the purgative powers of white hellebore are known to be weaker than those of the black, the distinction is so far applicable to the effect now experienced of the two roots now known.

The famous Anticyrian hellebore is supposed to be the black. Pausanias says, that both the white and black hellebore grew at Anticyra; but the latter was accounted safer, and therefore more commonly employed.

Not only the roots, but every other part of the plant of white hellebore, is acrid and poisonous, and is shunned by most animals. The dried root has no peculiar smell, but a nauseous, acrid, and bitter taste. When applied to open sores and ulcers, it produces its purging effect; and if snuffed up the nose, gives rise to violent sneezing. In large doses, it produces violent action on the intestines, followed by inflammation and death.

The ancients, though sufficiently acquainted with the powerful and dangerous effects of white hellebore, yet frequently prescribed it internally, especially in cases of melancholy madness, dropsy, epilepsy, and leprosy. Hippocrates gave it for the purpose of exciting vomiting, and deemed it safer when this action took place. To those of infirm and weak habits, to women, children, old men, and the consumptive, it was deemed inadmissible; and even when given to the robust, it was thought necessary to moderate its violence by different combinations and preparations; for it was frequently observed to effect a cure not only by its immediate action on the stomach and bowels, but when no sensible action was manifested.

Hellebore has not, however, kept its ground among the moderns, as a cure of madness; nor, indeed, is it now very much employed in any disease. Its violent action as a purgative, in which capacity alone it is looked to as a means of cure by modern practitioners, has perhaps been the cause of its disuse. The powdered bark of the root collected in spring, has been given in cases of melancholy madness, beginning with a grain, and increasing it to eight grains, and even to twenty; nausea, vomiting, purging, and increase of cutaneous and urinary secretions followed its use, together with redness of face, and efflorescence of the skin.

In diseases of the skin it is still employed with success, especially as an external application in the form of an ointment.

Black Hellebore (*helleborus niger)* Christmas Rose. *Ranunculaceæ.* The root is perennial, rough, knotted, and externally of a black colour, internally white, and sends off many strong, round fibres. The flower stalks are erect, round, tapering, and red towards the base. The bracteal leaves supply the place of a calyx, and are oval, concave, and generally indented at the top. The flower is large, with five whitish petals, tinted on the edges of a pink hue. The capsules, or pods, contain numerous, shining, blackish seeds. The leaves are compound, and are divided in a peculiar manner, or pedated. There are two pairs on each side, with a solitary centre leaf. It is a native of Austria and Italy, and was introduced into the gardens of this country by Gerard, in 1596. In mild weather it flowers in January, and hence has been called the Christmas flower. It is often confounded with other species, and hence the uncertainty of its supposed effects in medical experience.

The taste of the fresh root is bitter and somewhat acrid, leaving on the tongue a benumbed sensation, as of a loss of taste, similar to what occurs when the tongue is burnt with a drop of hot liquid. It also emits a strong nauseous smell; both these qualities, however, are impaired by drying and keeping. In its most active state its effects on the constitution are violent, and often dangerous. By the ancients it was employed as a purgative in cases of madness, and other diseases where there was obstinate costiveness. In modern practice it is much less employed; and chiefly in small doses, as an alterative in obstructions of the uterine discharge, and in dropsies.

An extract prepared by dissolving the root in water, and then evaporating it, is that preparation most employed; and it is given in doses varying from two to ten, and twenty grains, according to the object in view.

The Latin poets and writers have frequent allusions to this drug, and describe it as growing on the island of Anticyra, and about mount Olympus. Tournefort saw a species of this plant growing in great plenty in those localities.

Fetid Hellebore, or *Bear's-foot (h. fetidus)*, is another species which has been long used in Yorkshire and other places, by the country people, as a cure for the long round worm in children. The juice is an acrid and nauseous substance, and owes its virtues to its cathartic qualities. It is a native of many parts of England, and flowers in July.

Meadow Saffron, or Colchicum, *(colchicum autumnale)*. Natural family *liliaceæ; hexandria, trigynia*, of Linnæus. This plant is common in meadow grounds in England. It was first recommended to the attention of medical men by Baron Stoerck, of Vienna, and has latterly, again, come into considerable repute as a medicine.

The root is a perennial, succulent bulb, from which rises a long tube containing the flower, which is large, and of a purple colour. This flower appears in September, while the leaves make their appearance in the following spring. The active nature of the root varies probably according to age, and the nature of the soil. In its fresh state, it is acrid, pungent, and affects the stomach and bowels. From various observations made on the effects of colchicum by Baron Stoerck, and especially upon the infusion of three grains of the fresh root in four ounces of wine, he remarked, that its diuretic power was very considerable; and therefore concluded, that if its deleterious acrimony were destroyed, it might prove a useful medicine. Accordingly, he digested an ounce of the recent root in a pound of vinegar for forty-eight hours, with a gentle heat; the vinegar being then strained, it proved acrid to the taste, irritated the fauces, and excited a slight cough, to obviate which, he mixed the vinegar with twice its weight of honey, and gently boiled it down to the consistence of honey, forming an oxymal sufficiently grateful, and which, taken in doses of a dram, acted on the urinary organs, and also on the mucous membranes of the throat and lungs.

An infusion of the root in wine or vinegar is now commonly employed; and is found a most useful medicine in rheumatism, gout, and dropsy.

The leaves and roots of the common daffodil, narcissus, and other species of the family *liliaceæ*, are also possessed of acrid, purgative, and emetic qualities.

We recollect an instance where the leaves of the common daffodil were taken by a cook for leeks, and put into broth, the consequence of which was, that on two occasions where the broth was eaten, all those that partook of it were seized with sickness and vomiting. The circumstance excited considerable alarm and conjecture, until at last the mystery was cleared up by the mistake of the cook having been detected.

CHAP. L.

NARCOTIC PLANTS—OPIUM, HEMLOCK, HENBANE, BELLADONNA, &c.

The vegetable substances contained in this chapter, are characterised by possessing a peculiar principle called *narcotic*, which acts on the nervous system, in the first instance, it is supposed,

as a stimulant, and subsequently as a sedative. In this way they produce more or less of an exhilaration of spirits, and an increase of the actions and secretions of the body, followed, however, by a corresponding depression and inaction. In sufficient doses, they allay pain and nervous irregularity of action; in excess, they destroy the functions of life altogether. The active principle of all these plants resides in the natural juices, and varies in nature according to the particular plant.

Opium (*papaver somniferum*). Natural family *rhœades; polyandria, monogynia*, of Linnæus.

211.

White Poppy.

This celebrated drug is the expressed juice of a species of poppy. The root is annual, tapering, and branched; the stalk is round, smooth, erect, often branched, of a shining green colour, and rises two or three feet in height. The leaves are alternate, large, ovate, deeply serrated, and closely embrace the stalk. The flowers are very large, terminal, and usually white or purplish. The capsule is one-celled, divided half way into many compartments, which open by several apertures beneath the crown, and contain numerous small seeds. It is a native of the warmer parts of Asia, and is not uncommon in a wild state in England, growing in old neglected gardens, and even in the fields. It flowers in July and August.

This species is said to have been named white poppy, from the whiteness of its seeds; a variety of it, however, is well known to produce black seeds. The double-flowered white poppy is also another variety; but for medicinal purposes any of them may be employed indiscriminately, as no difference is discoverable in the sensible qualities or effects.

The leaves, stalks, and especially the capsules of the poppy, abound with a narcotic, milky juice, which, when exposed to the sun and air, hardens into the substance called opium. This substance may also be obtained, though in a much less pure or concentrated state, by boiling the above parts of the plant in water, and then evaporating it so as to form an extract.

Opium is chiefly obtained from Persia, Arabia, and other parts of India. The manner of cultivating the poppy in those countries, is thus detailed by Mr Kerr. The field being well prepared by the plough and harrow, and reduced to an exact level superficies, is then divided into quadrangular areas of seven feet long, and five feet in breadth, leaving two feet of interval, which is raised five or six inches, and excavated into an aqueduct for conveying water to every area, for which purpose they have a well in every cultivated field. The seeds are sown in October or November. The plants are allowed to grow six or eight inches distant from each other, and are plentifully supplied with water. When the young plants are six or eight inches high, they are watered more sparingly; but the cultivator strews all over the areas a compost of ashes and animal manure, and a large portion of nitrous earth, scraped from the highways and old mud walls. When the plants are about to flower, they are watered very profusely, and kept constantly moist. When the capsules are half grown, the supply of water is stopped, and the process of collecting the opium is commenced. At sunset they make two longitudinal double incisions upon each half-ripe capsule, passing from below upwards, and taking care not to penetrate the internal cavity of the capsule. The incisions are repeated every evening until each capsule has received six or eight wounds; they are then allowed to ripen their seeds. The ripe capsules afford little or no juice. If the wound was made in the heat of the day, a cicatrix would be too soon formed, while the night dews, by their moisture, favour the exudation of the juice.

Early in the morning old women, boys, and girls, collect the juice by scraping it off the wounds with a small iron scoope, and deposit the whole in an earthen pot, where it is worked by the hand in the open sunshine, until it becomes of a considerable thickness. It is then formed into cakes of a globular shape, and about four pounds in weight, and laid into little earthen basins to be farther dried. These cakes are covered over with poppy or tobacco leaves, and dried till they are fit for sale. Opium is frequently adulterated by an admixture of cow dung, the extract of the plant procured by boiling, and various other substances. At the period Mr Kerr wrote, towards the end of the last century, there were 600,000 pounds of opium exported from the Ganges. Since that time the trade has greatly increased, especially since the opium trade with China has prodigiously increased the demand.

The cultivation of the white poppy, and the manufacture of opium, has been several times tried in Britain, and several years ago by Dr Young, in the vicinity of Edinburgh. The uncertainty of the seasons, however, and the fre-

quent absence of the sun with rainy weather, were found to be very great drawbacks to the successful cultivation of this drug, in considerable quantity. In strength and medicinal effects, however, the British opium equalled that of warmer climates.

There are two kinds of opium imported into this country:

Turkey opium is a solid compact substance, possessing a considerable degree of tenacity, with a shining fracture, and uniform appearance when broken; and of a dark brown colour, exciting at first when chewed, a nauseous, bitter taste, which soon becomes acrid, with some degree of warmth, and having a peculiar, heavy, disagreeable smell. The best pieces are the flat or compressed, the round masses being of inferior quality.

East Indian opium has much less consistence, being sometimes not much thicker than tar, and always ductile. Its colour is much darker, its taste more nauseous, and less bitter, and its smell rather empyreumatic. It is considerably cheaper than Turkish opium, and is supposed to be of one-half the strength. One-eighth of the weight of the cakes is allowed for the large quantity of leaves with which they are enveloped. In the East Indies, when opium is not good enough to bring a certain price, it is destroyed under the inspection of public officers.

Opium is soluble in water and spirits; the latter forms the tincture of opium or laudanum.

The chemical analysis of opium shows it to be a compound of morphium and narcotine, the two principles on which its action on the body depends; as also of mecomic acid, a substance like caoutchouc, one like fibrina, a resin, gum, starch, fixed oil, and lignine.

The action of opium on the animal system has been the subject of much controversy. Some asserting that it is a direct sedative, while others maintain that it is a powerful stimulus. The truth appears to be, that it is capable in the first instance, of producing great excitement, while the sedative effects, which always succeed, are much greater in proportion than the previous excitement. In small doses it is decidedly stimulant. The pulse is accelerated, the heat of the body is raised, and the mental energies roused and excited. These effects are succeeded by languor, lassitude, and torpor. In larger doses, the stimulating effects are not so apparent; but the excitability of the system is remarkably diminished, and confusion of the head, giddiness, and sleep, are produced. In excessive doses, it causes headache, delirium, apoplexy, and death.

By habit, the effects of this drug on the body are greatly diminished; one, two, and three grains produce marked effects at first; and cases have occurred of death from swallowing even four grains: by degrees, however, the habit of daily taking opium will enable a person to swallow with impunity 20, 40, 60, and 100 grains, and upwards. The habitual use and abuse of opium, produces the same effects on the constitution as dram drinking, such as dyspepsia, with total loss of tone of the stomach; tremors, palsy, stupidity, general emaciation, and premature decay. In eastern countries, opium is not only taken into the stomach, but is also smoked like tobacco, the inhaled fumes producing the same stupifying effects as the solid drug. Few of those infatuated wretches who once yield to this debasing vice, ever have the resolution or power to abandon it.

The use of this celebrated medicine, though not known, or at least alluded to, by Hippocrates, was familiar to Diagoras, who immediately succeeded him. It was anciently prepared at Thebes, and hence the name of *Thebaicum* by which it was long known. This differs from the *meconium* of the ancients, which was the expressed juice of the plant, obtained by decoction in water.

As a medicine, it is the chief narcotic of modern practice, and is universally used in diseases to mitigate pain, diminish over sensibility of the system, to procure sleep, check looseness of the intestines, and other excessive discharges. It is improper, however, in all cases of an inflammatory nature, where previous bleeding or evacuations have not been used. It also requires much skill and management in its exhibition. Reference always being had to the peculiarities of the constitution, the nature of the disease, and the regulation of the dose, or the medicines with which it may be combined. Thus, with ipecacuan, it produces perspiration; with calomel, it allays certain states of inflammation; and with purgatives, it relieves colic, pain, and looseness of the bowels.

LETTUCE *(lactuca virosa)*. *Syngenesia, polygamia, equalis* of Linnæus. This is a common perennial plant in meadows, and on the sides of ditches. The stalk is about three feet high, the root leaves are cut into deep clefts, the edges serrated; the stem leaves are arrow-shaped, entire, and embrace the stalks. The flowers are composed of numerous, equal, yellow florets, and appear in July and August.

The plant has a strong, unpleasant smell, very similar to that of opium; and a bitter, acrid taste. It abounds in a milky juice, which, when scraped off and hardened, has a strong resemblance to opium.

Dioscorides, the Greek physician, seems to have looked upon the effects of the juice of this plant as similar to that of the white poppy. Dr Collin of Vienna first brought it into notice in modern times, as a cure for dropsies. It has not, however, in further experience, maintained its reputation.

The common garden lettuce also yields a milky

juice, which, in its action, resembles that of opium, though in a milder degree. This juice is collected when the plant has put forth its flower stem, by cutting this stem across, and collecting the juice by successive small pieces of cotton, which are thrown into a little water; and after a sufficient quantity has accumulated, this water holding in solution the contents of the pieces of cotton, is evaporated, and an extract is thus procured. It may also be procured at less expense, by macerating in water the stems and leaves, just after the seeds have been matured, and before the plant decays. The maceration is to be continued for twenty-four hours, then the liquid is boiled for two hours, and finally evaporated in shallow basins. This extract is called *lactucarium*, or lettuce opium. It is said to allay pain, and procure relief in rheumatism, colic, and affections of the bowels, and to have less of the disagreeable effects which opium not unfrequently produces.

Hemlock *(conium maculatum)*. Natural family *umbelliferæ; pentandria, digynia*, of

215.

Hemlock.

Linnæus. There are two kinds of hemlock, the water hemlock, and the common. The common hemlock is a biennial plant, very common in waste grounds. The stalk rises to the height of five or six feet. It is hollow, jointed, and thickly marked externally with brown spots. The lower leaves are very large, tripinnated, of a shining green colour, with long, concave footstalks. The upper leaves are much smaller. The flowers are produced in umbels; and both they and the seeds bear a close resemblance to another plant of the same natural family, the common carraway.

The *Water Hemlock (cicuta virosa)*, is found growing on the borders of pools and rivers; it strongly resembles the former, only the pinnæ of the leaves are larger, and lanceolate; and the umbel of the flowers is denser, and more compact. The stem is not spotted like the common hemlock, and the odour of the plant resembles that of smallage or parsly; while that of the common hemlock is nauseous, and peculiarly unpleasant. Both plants are poisonous. The root of the water hemlock is acrid, and powerfully poisonous in its fresh state, but loses its virulent qualities when dried. The root of the common hemlock possesses little or no active powers; but the other parts of the plant are decidedly poisonous, if taken in sufficient quantity. Sheep and some other animals eat it with impunity, while, to the greater number, it proves an active poison.

The ancients were familiar with the poisonous nature of hemlock; but from their descriptions of the plant, it is not well ascertained whether the water hemlock or the common, *(maculatum)* was the species they employed. Perhaps, indeed, they were in the habit of using both. The juice of hemlock was frequently administered to criminals; and this was the fatal poison which the greatest of Greek philosophers, Socrates, was adjudged by his persecutors to drink. The symptoms produced by a poisonous dose of hemlock are: great anxiety, vomiting, convulsions, stupor, raving, madness, and death. In smaller doses it may, and is, however, used internally, without producing any of these symptoms. Externally, both the Greek and Arabian physicians were in the practice of using it for the cure of indolent tumours, swellings, and pains of the joints, as well as for affections of the skin. Among the moderns, Baron Stoerck was the first who called the attention of medical men to the use of *cicuta*, both externally and internally, for the cure of cancerous and other ulcers. Although further experience has not altogether confirmed the high praises bestowed on it by this German physician, yet it has been found a useful medicine for affording relief in those malignant diseases. It is used in the form of an extract, and the seeds are said to yield a stronger one than the leaves, or other parts of the plant. The leaves are also used either as a tincture in spirits, or dried and formed into a powder. These leaves should be gathered about the end of June, when the plant is in flower. The small leaves should be selected, and the stalks picked out and discarded. The leaves are then dried in the sun, or in a pan before a good fire, and are then to be put into strong paper bags, and kept in a close drawer; or they may be powdered and put into glass-stopped phials, taking care to exclude them from the light. The medical activity of this plant is said to reside in a resinous substance, which may be obtained by evaporating a solution of the leaves made in ether. It has a rich dark green colour, and contains the peculiar odour and taste of hemlock.

Hemlock Water-dropwort (œnanthe crocata). This is also a poisonous plant, which grows on the

banks of rivers and ditches, and flowers in June and July. The root is perennial, the stalk channeled, smooth, and of a yellowish red colour, and two to three feet in height. The leaves are simply and doubly pinnated; the larger pinnæ three-lobed; the flowers in a spreading globular umbel. The root is not unpleasant to the taste, but is a virulent poison. Mr Howell mentions, that during the late war, eleven French prisoners had the liberty of walking for a short distance around the town of Pembroke. Three of these being in the fields a little before noon, dug up a large quantity of this plant, which they took to be wild celery, to eat with their bread and butter for dinner. After washing it they all three ate, or rather tasted of the roots. As they were entering the town, without any previous notice of sickness at the stomach, or disorder in the head, one of them was seized with convulsions, the other two ran home and sent a surgeon to him. The surgeon endeavoured first to bleed, and then to vomit him; but those endeavours were fruitless, and he died presently. Ignorant of the cause of their comrade's death, and of their own danger, the two men gave of these roots to the other prisoners, who all ate some of them with their dinner. A few minutes afterwards, the remaining two who gathered the plants were seized in the same manner as the first, of which one died; the other was bled, and an emetic with great difficulty forced down, on account of his jaws being locked together. This operated, and he recovered; but was sometime affected with dizziness in his head, though not sick, or the least disordered in his stomach. The other eight being bled and vomited immediately, recovered.*

At Clonmel, in Ireland, eight boys mistaking this plant for water parsnip, ate plentifully of its roots. About four or five hours after, the eldest boy became suddenly convulsed, and died; and before the next morning, four of the other boys died in a similar manner. Of the other three, one was maniacal several hours; another lost his hair and nails; but the third escaped unhurt. In other cases where children ate the root by mistake, burning heat in the stomach, great agony, sickness, vomiting, and convulsions followed.

The leaves and juice of the plant are equally deleterious. Goats brouse on it with impunity, but to most other animals it proves a poison. Even the odour of the plant, if long inhaled, causes nausea and giddiness. This plant is not commonly used as a medicine, although, in some cases, it has been taken with effect in eruptive diseases of the skin. It should be given at first in small doses, gradually increased.

HENBANE (*hyosciamus niger*). Natural family *solaneæ; pentandria, monogynia*, of Linnæus. The black henbane is a biennial plant, which grows wild in Britain, and is to be found commonly among rubbish, and on road sides. The root is long, compact, and fibrous. The stalk is round, woody, branched, and about two feet high. The leaves are large, deeply divided into irregular lobes, and of a sea-green colour, woolly, and with their base embrace the stem. The flowers grow in irregular clusters at the tops of the branches. The corolla is funnel-shaped, consisting of a short tube, with an expanded limb, divided into five obtuse segments; of a dingy yellow colour, with many minute, purple veins. The capsule is oval, two-celled, and contains many small, irregular, brown seeds. The plant flowers in June. The smell of the whole plant is strong and peculiar. The bruised leaves emit an odour somewhat like that of tobacco. This odour is still stronger when the leaves are burnt, and on ignition they sparkle with a crackling noise, somewhat like the deflagration of nitre. To the taste the leaves are mild and mucilaginous.

All parts of the plant, the roots, seeds, and leaves, when taken into the stomach in sufficient quantity, prove a powerful narcotic poison. A French physician relates that nine persons, having eaten by mistake the roots of henbane, were seized with most alarming symptoms. Some were speechless, and showed no other signs of life than by convulsions and contortions of the limbs; others uttered terrible howlings, and exhibited strong muscular convulsions: in all, the eyeballs stared from their sockets, and their mouths were drawn backwards on both sides. On recovering, all objects appeared for several days of a red scarlet hue. "Four children," says Sir Hans Sloane, "who ate the berries, mistaking their capsules for filberts, were seized with great thirst, swimmings of the head, dimness of sight, ravings, and profound sleep, which last, in one of the cases, continued for two days and nights.

Dr Stedman relates a case in which the leaves were boiled by mistake in broth, which was eaten by seven persons. "I saw them," says he, "about three hours after, and then three of the men were become quite insensible, did not know their comrades, talked incoherently, and were in as high a delirium as people in the rage of a fever. All of them had low irregular pulses, slavered, and frequently changed colour; their eyes looked fiery, and they catched at whatever lay next them, calling out that it was going to fall."

This plant proves also a poison to some animals, as to birds and dogs; while cows, horses, goats, and pigs, eat it with impunity.

In medicine this plant has been used from the earliest records. Dioscorides employed it to pro-

* Philosoph. Transact. vol. 44.

cure sleep, and allay pains; and Celsus and others have made use of it for the same purposes, both externally and internally. Its modern use was revived by Baron Stoerck, who gave it in the form of an extract, in cases of epilepsy, and other nervous and convulsive diseases.

In modern practice it is employed in all those cases where opium is found not to suit the particular constitution. As it is of a laxative tendency also, it is employed in preference to opium, where it is of importance to preserve the due action of the bowels.

The usual preparations are an extract made by evaporating the inspissated juice, the dose of which is from a grain to fifteen, twenty, and even thirty, increased gradually.

A spirituous tincture is also prepared from the leaves, which is about one-half the strength of laudanum. Externally, both those preparations are used in rheumatism and local pains, and in certain diseases of the eye. A watery solution of the extract applied to the eye, has a similar effect with that of belladonna in dilating the pupil, and thus preparing the eye for an operation, or assisting the cure of its internal inflammation. This dilatation leaves no injurious effect afterwards. Poultices of the leaves are also applied to indolent tumours, and irritable sores. Its effect in cancerous sores, however, is only to allay pain.

Deadly Nightshade *(atropa belladonna)*. Natural family *solaneæ; pentandria, monogynia,*

216.

Deadly Nightshade.

of Linnæus. This plant, which is found growing in shady situations and waste grounds in this country, belongs to a natural family which all possess, in a greater or less degree, the narcotic poisonous quality.

The root is thick, whitish, and perennial, sending forth annually a strong, branched, purple coloured stem, from three to five feet high. The leaves are of unequal size, and are entire, oval, pointed, standing in pairs on very short footstalks. The flowers are large, bell-shaped, pendent, and of a brown purple hue; appearing in June or July, and producing a round purple berry, which ripens in September. The whole plant is covered with a fine down.

Dioscorides and other Greek physicians were in all probability acquainted with this plant, though their descriptions are not sufficiently minute so as to identify it. Sauvages supposes that the belladonna was the plant which produced such strange and dreadful effects upon the Roman soldiers under the command of Anthony, during their retreat from the Parthians. In this retreat they suffered great distress in the want of provisions, and were urged to eat unknown plants; among others they ate one which had a deleterious effect, so that he that had eaten of it, lost his memory and his senses, and employed himself wholly in turning about all the stones he could find; and after vomiting up bile, fell down dead. Buchanan, the Scotch historian, also relates that the Scots mixed the juice of the belladonna with the bread and drink which by their truce they were to supply the Danes with, which so intoxicated them, that the Scots killed the greater part of Sweno's army while asleep. The root, the leaves, the juice, and the berries of this plant, are all more or less poisonous. The latter are often eaten by children; and if more than three of them be taken into the stomach, sickness, great heat, and thirst, painful swallowing, giddiness, delirium, and convulsions follow. The eyelids are drawn down, the iris is dilated and immovable, the face becomes red and swelled, and spasms affect the jaw. The sensibility of the stomach and other organs becomes so paralyzed, that the strongest emetics have no effect; while the action of the heart is gradually diminished, till death takes place. After death, the coats of the stomach and bowels exhibit signs of inflammation. Strong emetics, the stomach pump, and afterwards draughts of vinegar and water, should be used as a means of cure when these berries have been swallowed.

The leaves of this plant were at an early period used internally in cases of glandular swellings and cancerous tumours, as also to ulcers. Their beneficial effects in these cases, led physicians to employ them internally for the same disorders, when they were in many instances successful. Dr Cullen says, "I have had a cancer of the lip entirely cured by it; a schirrosity in the breast, of such a kind as frequently proceeds to cancer, I have found entirely discussed by the use of it: a sore a little below the eye, which had put on a cancerous appearance, was much mended by its internal use; but the patient having learnt somewhat of the poisonous nature of the medicine,

refused to continue the use of it, upon which the sore again spread, and was painful; but upon a return to the use of the belladonna, was again mended to a considerable degree, when the same fears again returning, the use of it was again laid aside, and with the same consequence of the sore becoming worse. Of these alternate states connected with the alternate use of and abstinence from the belladonna, there were several of these alternations which fell under my own observation."

The dose of this medicine, like all other narcotics, should be begun in small quantity, as a grain, and gradually increased. Six grains of the dried leaves of belladonna is reckoned an average full dose. A watery infusion of the leaves also, contains all the virtues of the plant.

Externally, it is used in local pains and swellings, and to dilate the pupil of the eye in some of its diseases, and previous to the operation for cataract. For this purpose, a few drops of the infusion may be dropped into the eye, or the extract may be rubbed on the external part of the eyelids. In about four hours the greatest degree of dilatation takes place.

The active principle of belladonna has been discovered to be of an alkaline nature, and is called *atropium*. Mr Brandes, the discoverer, on tasting a small quantity of the *sulphate* of *atropium*, which was rather salt than bitter, experienced extreme confusion of head, trembling in all his limbs, alternate rigours and heat, violent tension of the chest, difficulty of breathing, sinking of the pulse, and retching. The most severe of these symptoms abated in half an hour.

MANDRAKE *(atropa mandragora)*. The root is perennial, and three or four feet long. The leaves are radical, sessile, ovate, entire, waved.

There is no stem; but the flowers, which are white, with a bell-shaped corolla, divided at the top into five notched segments, stand upon simple stalks. The fruit is a large two-celled berry, of an orange colour, containing many kidney-shaped seeds.

This plant is a native of the southern parts of Europe, where it flowers in March and April. It was cultivated in England by Turner, in 1562, and is not uncommon in English gardens.

The superstitious and absurd fables formerly told of the mandrake, would not now for a moment impose upon the most credulous and ignorant. The great resemblance of some of the roots to the human form, the danger of taking them out of the ground, and their surprising effects, were all the invention of empirical knavery and imposture.

The ancient writers represent the root of this plant to be possessed of an anodyne and soporific quality; in large doses, it is said to excite delirium and madness. They used it for procuring rest and sleep in continued watchings, and in those painful diseases that resisted other remedies; in melancholy, convulsions, rheumatic pains, and scrophulous tumours. They used the bark of the root, either expressing the juice, or infusing it in wine or water. The leaves boiled in milk, and used as a poultice, were employed by Boerhaave as an application to indolent tumours. Hoffberg, also, employed the root in discussing swellings of the glands, and internally in the form of a tincture.

There is no doubt but mandragora has the narcotic qualities in considerable strength; yet it is rarely employed in modern practice.

Garden Nightshade (solanum nigrum). This annual plant is common in this country, and grows about rubbish and dunghills. The flower is very like that of the common potato. The stalk is about a foot in height; the leaves are alternate, irregularly ovate, waved in the margins, and covered with soft down. The fruit is a round, two-celled berry, of a black colour when ripe, and contains several kidney-shaped, yellow seeds. The smell of the plant is faint and disagreeable. It has very little taste, but it possesses the narcotic qualities of the class to which it belongs in a considerable degree; even the odour of the plant is said to cause sleep. The berries are equally poisonous with the leaves. Three children, upon eating them, were seized with burning heat of the stomach and delirium, accompanied by spasms and distortions of the limbs. The leaves boiled in water, and eaten by a mother and four children, produced swellings of the face and limbs, followed by inflammation and mortification; but the husband, who partook of the same mess, felt no disorder. The berries prove a deadly poison to poultry. Dioscorides and Theophrastus mention this plant as employed as an esculent; at the same time they used it as an external application to swelled glands, ulcers, eruptions of the skin, and diseases of the eyes. The Arabians also employ it in the same manner; and Ray speaks highly of its effects in removing swellings of the breast. It is not much used in the modern practice of the healing art.

Woody Nightshade (solanum dulcamara). This is also a common plant, which grows in hedges in moist situations. The stalk is slender, climbing, covered with bark of an ash colour, and rises to six or seven feet in height. The leaves are long, oval, and pointed, those near the top are spear-shaped. The flowers are purple coloured, with long yellow anthers. The fruit is an oblong, reddish berry, containing many flat, yellow seeds.

The roots and stalks, on being chewed, first cause a sensation of bitterness, which is soon followed by a considerable degree of sweetness; and hence the plant obtained its name of bitter-

sweet *(dulcamara)*. The berries act powerfully on the stomach and bowels, exciting both vomiting and purging. Thirty of these were given to a dog, which soon became mad, and died in the course of three hours;* and upon opening his stomach, the berries were discovered to have undergone no change by the powers of digestion. There can therefore be little doubt of the deleterious nature of these berries; and as they are very common in hedges, and may easily be mistaken by children for red currants, which they somewhat resemble, the greatest care should be taken to point out their danger. The stem and young branches are the parts employed in medicine; and these are said to be strongest in autumn, after the leaves are shed.

Dulcamara does not exhibit those decided narcotic qualities that the other species do. It is said, however, to act as a general stimulant, by increasing all the secretions of the body when given in moderate doses; in larger quantities, it produces sickness, vomiting, and convulsions. Much of its activity seems to depend on the soil in which it grows. In light dry soils, and warm climates, its powers are very greatly increased. It has been recommended in rheumatism, affections of the skin, glandular swellings, and ulcers. A decoction of the young twigs in water, is the form usually employed.

STRAMMONIUM OR THORN APPLE *(datura strammonium)*. This plant, belonging to the same natural

217.

Strammonium.

family as the above, is a native of America; it is also a common annual in this country, growing about dunghills, and among rubbish. The stalk is thick, smooth, and shining, growing to the height of two feet. The leaves are alternate, large, broad towards the base, pointed at the extremities, indented, and formed into several obtuse angles. The flowers are large, solitary, white, with a tubular, pentangular calyx, and funnel-shaped corolla. The capsule is large, oval, fleshy, beset with long spines, and divided into cells.

The strammonium, in its recent state, has a bitterish taste, and a smell somewhat resembling that of poppies. It has strong narcotic qualities. The odour of the plant is said to induce giddiness and stupor; and the leaves, stem, or capsule, if taken into the stomach, produce all the effects of a poison. The seeds are the most powerfully narcotic part of the plant; and instances have occurred where they were eaten by mistake, and death followed. When taken into the stomach in moderate quantity, they produce a sort of intoxication, followed by a deep sleep. M. Brandes has discovered the peculiar active principle of these seeds, and has termed it *daturine*.

This plant, or an allied species, was known to the ancient Greek physicians. In modern times, it was first tried as a remedy in mania and melancholy, by Baron Stoerck. Several cases of the same diseases were also cured or relieved by it, under the direction of different Swedish physicians. It has also been employed, and sometimes with advantage, in convulsive diseases. Dr Barton considers it to be a medicine of general efficacy. He gives it in powder, beginning with doses of a few grains, gradually increasing to fifteen and twenty grains. In a case where thirty grains were given, it dilated the pupil of one eye, and produced paralysis of the eyelids, which was removed by a blister. The smoke of the dried root and stem, has been much extolled for the cure of asthma. This practice was derived from the East Indies, where other species of the plant are employed. For this purpose the root and lower parts of the stem are to be dried quickly, and cut into pieces, and then beat so as to divide the fibres. Part of them are put into the bulb of a tobacco pipe, and the smoke is first to be taken into the mouth, and then inhaled into the lungs. This is said to excite a heat in the chest, followed by copious expectoration; sometimes there is giddiness and drowsiness, but rarely nausea. It frequently gives relief when a pipe is thus smoked, upon a paroxysm being threatened, or even after its commencement. The patient generally falls asleep, and awakes relieved. In some cases a perfect cure is effected, but more commonly, according to the predisposing cause, the relief is only temporary.

Dr Marcet highly extols an extract prepared from the seeds, in preference to that from the whole plant. In doses of from one-eighth of a grain to a grain, he says, in cases of chronic disease, attended with acute pain, it produces almost immediate relief. It also occasions a sort of nervous shock, which is frequently attended with a momentary affection of the head and eyes, with a degree of nausea, and with a feeling of intoxication. In many instances it excites nervous sensations, which are referred to the œsophagus, or windpipe, causing a feeling of suffocation. It does not produce direct sleep, but rather ease and free-

* Woodville's Botany.

dom from pain; nor has it a tendency to constipate the bowels, but has rather an opening effect.

FOXGLOVE *(digitalis purpurea).* Natural family *solaneæ; didynamia, angiospermia,* of

218.

Digitalis.

Linnæus. This plant, well known by its beautiful pyramidal spike of bell-shaped flowers, grows commonly about road sides, hedges, rocks, and quarries, in dry gravelly soils. The root is biennial, the stalk erect, simple, and tapering. The leaves are large, oval, obtusely serrated on the edges, downy, and stand on short footstalks. The flowers grow on a long terminal spike, chiefly on one side: they are large, monopetalous, pendulous, and bell-shaped; purple in one variety, white in another. The capsule is bilocular, and contains many blackish seeds. The flowers appear in June and July.

The leaves are the medicinal parts of the plant. They have little smell, but a bitter, nauseous taste. In large doses they produce the usual effects of a poisonous narcotic, as vomiting, purging, dimness of sight, giddiness, and delirium, followed by death; in moderate and regulated doses, their medicinal effects are: to diminish the frequency of the pulse, and the irritability of the system; to increase the action of the absorbents, and the action of the urinary organs. Ray, and the earlier English physicians, were acquainted with many of the effects of this plant; but Withering first discovered its diuretic properties. For some time digitalis was in great vogue for the cure of dropsy and consumption; but being used indiscriminately in all kinds of these complaints, it of course was found to fail in very many cases, and thus suffered a diminution of its high reputation. It is still, however, reckoned a useful and powerful medicine by the discriminating physician, and is employed, in inflammatory affections, to reduce the energy of the heart; in hemorrhage, proceeding from ruptured vessels of the lungs; in aneurism or enlargement of the arteries; and in dropsical affections of the chest and abdomen.

Withering directs the leaves to be gathered after the flowering stem has shot up, and about the time when the blossoms are coming forth; the leafstalk and midrib are to be rejected, and the leaves are to be dried in the sun or before a fire. When dry they are easily reduceable to a beautiful green powder, the dose of which is from one grain to three or four, in the course of the day. The leaves also yield their virtues to water, forming an infusion; or to spirits, forming a tincture. While using this medicine as a diuretic, copious draughts of water, or any bland fluid, should be taken at same time. In many cases of dropsy, the good effect of digitalis is only available after bleeding, and other means of evacuation have been practised.

The beauty of this plant has recommended it to the notice of the florist, and it is accordingly often found in the garden parterre. It also forms an ornamental and conspicuous object in many mountain and woodland scenes, in Scotland and Wales. Among the country people it has received various names. In the south of Scotland it is called "bloody fingers;" in the north, "dead man's bells." In Wales it is called "fairies' gloves." Fairies were often called "folks;" hence no doubt the origin of the common name, "folks glove," and not as, misspelt, "fox glove."

NUX VOMICA *(strychnos nux vomica).* Natural family *solaneæ; pentandria, monogynia.* The

219.

Nux Vomica.

tree which bears the vomic nut, is a native of the East Indies. It is of considerable size, and sends off numerous strong branches, covered with dark gray, smooth bark. The young branches have a knotted, jointed appearance. The leaves arise at the joints in pairs, upon short footstalks, and are broad, oval, and pointed, with from three to five ribs. The flowers terminate the branches in a kind of umbel. The corolla is small, bell-shaped, and of a white colour. The fruit is a round, smooth, large, pulpy berry, externally yellow, and contains within several round depressed seeds, covered with downy, radiated hairs. These seeds afford the substance known under the name of nux vomica; they are flat, round, about an inch broad, and a quarter of an inch thick, with a prominence in the middle; on both sides of a gray colour, covered with a kind of woolly matter, and internally

hard and tough, like a horn; to the taste they are extremely bitter, but have no smell. They consist chiefly of a gummy matter, and a resin, soluble in alcohol, to which it imparts an intensely bitter taste. *Strychnine* is the name of that peculiar active principle contained in the resin of these seeds.

Nux vomica may be classed among the most powerful of vegetable narcotics. To man and most animals, it proves a virulent poison. Administered to dogs, hares, foxes, wolves, cats, rats, rabbits, and several kinds of birds, it produced death in a very short time.

A horse after having taken a dram of the half roasted seeds, died in the course of four hours. Its effect upon different animals, even of the same species, varies, however, greatly, and does not seem to depend always on the quantity taken. With some animals its effects are instantaneous: with others, not till after several hours, when laborious respiration, followed by stupor, tremblings, coma, and convulsions, usually precede the extinction of life. Its effects on the human subject are exactly similar; and from no appearances of inflammation, being visible on the stomach or intestines after death, it appears that the poison acts immediately on the nervous system, and speedily destroys life by the virulence of its narcotic qualities.

The quantity necessary to produce fatal effects on a strong dog, need not exceed a scruple; a rabbit was killed by five, and a cat by four grains; and a girl of ten years of age was poisoned by a dose of fifteen grains. It is frequently employed mixed with meal, to poison rats, and proves an effectual means of destroying these vermin.

Although many trials have been made of exhibiting this substance internally for the cure of diseases, especially in Germany and Sweden, yet it has never come into very general use as a medicine; externally, however, it has been employed, especially of late, as a powerful and useful stimulant in local and general affections, accompanied by a loss of nervous power and muscular energy.

Wolf's Bane, or Monkshood *(aconitum napellus)*. Natural family *ranunculaceæ; polyandria, trigynia*, of Linnæus. This is a perennial plant, with a turnip-shaped root. The stalk grows erect, to the height of three or five feet. The leaves are lobed, deeply laciniated, and stand alternately upon long footstalks; the upper leaves being, however, almost sessile; the upper part dark green, the under whitish. The flowers terminate the stalk; they are without calyces, and grow in a long raceme. Each flower consists of five petals, which include two nectaries; the uppermost petal is arched over the lateral ones, so as to appear like a helmet or hood; the colour is purplish blue, or deep violet. This plant is a native of the mountainous or woody parts of Germany and Switzerland, and was introduced into Britain by Gerard. It is now a common plant in flower borders.

Every part of the fresh plant is a virulent poison; but the root is unquestionably the most powerful, and when first chewed, imparts a slight sensation of acrimony, but afterwards an insensibility or stupor, to the apex of the tongue; and a pungent heat of the lips, gums, palate, and throat, are perceived, followed by a general tremor, and sensation of chillness. Though the plant loses much of its power by drying, yet when a little of the powdered root is put upon the tongue, it excites a durable sense of heat, and sharp wandering pains, but without redness or inflammation. The juice applied to a wound, affects the whole nervous system; even by keeping it long in the hand, or on the bosom, it is said to produce unpleasant symptoms. When taken into the stomach, it causes sickness, vomiting, convulsions, delirium, violent purging, cold sweats, and death. Like the other narcotics also, it seems to act directly on the nervous system, without causing any visible action on the coats of the stomach. It proves fatal to all animals on whom it has been tried. The ancients were well aware of the baneful qualities of aconite, and fabled it the invention of Hecate, or the virulent froth of Cerberus. Ray states it as the most certain and sudden of all poisons.

The root was administered by way of experiment, to two condemned criminals at Rome, in the year 1524; and to other two at Prague, in 1561, two of whom quickly died, while the other two with difficulty recovered. It has frequently been eaten in mistake for other plants, and proved fatal; a remarkable case is recorded to have occurred in Sweden. A person having eaten some of the fresh leaves, became maniacal; and the surgeon who was called to his assistance declared that the plant was not the cause of the disorder. To convince the company that in his opinion it was perfectly innocent, he ate freely of the leaves, and soon after died in great agony.

Among the moderns, Stoerck was the first to introduce it into practice; and it was exhibited by him and several German physicians, chiefly in cases of rheumatism, and with very favourable results. It has also been found an efficacious remedy in glandular swellings, stiff joints, and old cases of gout and rheumatism. The usual preparations of the plant are the dried leaves powdered, or the expressed juice of the plant dried to the consistence of an extract. A grain of either of them may be given at first, and gradually increased. The strength, however, varies very much, according to circumstances. It is always most powerful when recently prepared, and loses its virtues gradually, accordiug to the time it is kept.

DANDELION *(leontodon taraxacum)*. Natural family *compositæ; syngenesia, polygamia equalis,* of Linnæus. This is perhaps one of the commonest weeds, the small seed being furnished with a downy appendage, which readily carries it along upon the wind, and diffuses it in all waste places. The leaves are radical and deeply indented, in such a way as has been termed *runcinata*. The flower stalk is simple, fistulous, coloured of a pinkish hue, and bears one flower. The outer calyces are bent downwards. The seeds, which are numerous, are crowned with a fine downy feather, and are disposed in a spherical shape.

The young leaves, in a blanched state, have the taste of endive, and are frequently used in spring, mixed with other salad plants. In Germany, the roots are roasted and substituted for coffee by the poorer inhabitants, who say that an infusion prepared in this way, can hardly be distinguished from that of real coffee. This plant yields a milky juice similar to that of the lettuce and others. It is bitter, and somewhat acrid; but the juice of the root is still more powerful. It has been found a general stimulant to the system, but especially to the urinary organs. Some of the older physicians recommend it in obstructions of the liver, and hypochondriacal diseases. In modern practice, however, it is superseded by more active medicines, of a similar tendency.

YARROW, OR MILLFOIL. Natural family *compositæ; syngenesia, polygamia superflua,* of Linnæus. This is a common perennial plant, found in dry pastures on the steep banks of rivers, in Britain. The stalk is smooth and downy, and grows to the height of ten or twelve inches. The leaves stand alternately on the stem, which they partly embrace, and are subdivided into a double series of pinnæ; they are numerous, narrow, and somewhat pointed. The flowers are small, white, or purplish, and terminate the stem in a close corymb. Both the flowers and leaves have an aromatic, rather agreeable smell, and a bitter, rough, and somewhat pungent taste.

Both water and proof spirit extract the virtue of this plant; and by distillation it yields a penetrating, essential oil, possessing the peculiar flavour of the plant in perfection.

The millfoil was known to the ancient physicians, and was esteemed by them as a cure for wounds and bleeding vessels; but the modern art of surgery has now dispensed with all such applications.

Internally, it has been used in Germany as a tonic, antispasmodic, and sedative. That it possesses some narcotic qualities, would appear from the fact in Sweden, that it is used in making beer, to which it imparts an additional intoxicating quality. In modern practice, it is never used as a medicine.

CHAP. LI.

GUMS, RESINS, AND BALSAMS.

IN a former part of this work,* we described generally the various vegetable products obtained from plants; and, amongst others, the gums, resins, and balsams. We shall now more particularly describe the trees and plants from which those substances, as far as known, are obtained.

By gum or mucilage, is understood a substance soluble in water, but insoluble in alcohol. Resins are, on the contrary, soluble in alcohol and the essential oils, but insoluble in water. Gum resins are substances composed both of resin and gum, or mucilage; and balsams are combinations of one or both of these, with benzoic acid.

GUM ARABIC TREE, OR EGYPTIAN THORN *(acacia vera)*. Natural family *leguminosæ; polygamia, monœcia,* of Linnæus. This is a stunted, hard, withered looking tree, with a crooked stem, covered with smooth, gray coloured bark. The leaves are bipinnated, and placed alternately; the partial pinnæ are opposite, furnished with a small gland between the outermost pair, and beset with numerous pairs of narrow, elliptical leaflets. The spines are long, white, spreading, and proceed from each side of the base of the leaves. The flowers are hermaphrodite and male; they assume a globular shape, and stand four or five together upon slender peduncles, which arise from the axillæ of the leaves. The calyx is small, and the corolla consists of five small, narrow segments, of a yellowish colour. The fruit is a long pod, resembling that of the lupine, and contains many flat, brown seeds. It is a native of Arabia, and found in almost every part of Africa. It flowers in July. This and all the other species of the same family, are easily cultivated in our green-houses. The first plant of acacia, cultivated in England, was by Evelyn, in 1664.

220.

Gum Arabic Tree.

This tree appears to have been well known to the ancients. Dioscorides not only mentions the

* Chap. xxi.

gum which it produces, but also a mucilage obtained from the immature pods. Alpinus and others describe the same plant, and its products.

Although this tree grows abundantly over the vast extent of Africa, yet the gum is procured chiefly from those plants growing near the equatorial parts of that continent; and it is said that in Lower Egypt, the solar heat is not sufficiently intense for promoting the exudation of the gum. This gum exudes in a liquid state from the bark of the trunk and branches of the tree; and by a short exposure to the sun and air, gradually hardens into a solid mass. In Senegal the gum begins to flow when the tree first opens its flowers, and continues during the rainy season till the month of December, when it is collected for the first time. At this period the Moors encamp on the borders of the forest, and the harvest lasts six weeks. The gum, which is in the form of round or oval masses, about the size of a pigeon's egg, is packed in very large sacks of tanned leather, and brought on camels and bullocks to certain ports, where it is sold to the French and English merchants. In the year 1787, according to the information of Golberry the annual quantity purchased by the former was about 800,000 pounds; and by the latter 400,000.

In Jackson's account of Morocco, it is stated that from Mogador they export two sorts of gum, one the common gum Arabic, the produce of Morocco, and called Barbary gum; the other finer, called gum Soudan, or Senegal, brought from Timbuctoo by the caravans. It is also there stated, that the gum called Morocco or Barbary gum, is produced from a thorny tree called atalleh, having leaves similar to the juniper. It yields most gum during the parching heat of July and August; and the hotter the weather, and the more sickly the tree appears, the more gum it yields: a wet winter, and a mild summer, being both unfavourable to its production.

Gum Arabic was originally brought from Arabia by the way of Egypt, to Marseilles; and it was not until the beginning of the seventeenth century, that the Dutch made the gum of Senegal known in Europe.

After the French got possession of that river, they directed their attention to it as an important object of commerce, and ascertained, by experiments made in the latter half of the seventeenth century, that gum Senegal was superior to the best gum of Arabia; and for about fifty years it has had the preference.

M. Adanson examined all the gum trees of West Africa with great care, and has given the best description of them. They amount to forty species; but the three great forests which supply the Senegal market, consists chiefly of two kinds, one which produces a white gum, called *vereck*, and another called *nebuel*, which yields a red gum.

There are two kinds of gum found in the shops, and often sold promiscuously; but distinguished in commerce by the names of gum Arabic, and East India gum.

Gum Arabic is in round tears, transparent, colourless, or of a yellowish hue, of a shining fracture, without smell or taste, and perfectly soluble in water. The pieces which are most transparent, and have least colour, are preferred, and are picked out and sold at a higher price. The East India gum is darker coloured, and not so soluble in water as the other. A gum produced from a species of acacia, in New Holland, is of a still darker colour, and when suspended in water, gives off whitish films; and in this and other respects, resembles the gum of the cherry, and other trees produced in this country. The coarsest gum makes the thickest mucilage, according to the experiments of the late Dr Duncan.

Gum Arabic is a highly nutritious article of food. During the whole time of the gum harvest in Barbary, the Moors of the desert live almost entirely upon it; and experience has proved that six ounces are sufficient for the support of a man during twenty-four hours. It is also used for food by the Hottentots of southern Africa; and Dr Sparrman states, that in the absence of other provisions, the Bushmen live on it for days together.

In medicine, it is employed as a demulcent in coughs and irritable states of the mucous membrane, for which it is well adapted, at the same time that it does not, like oily substances, load the stomach. It is also used in combination with other medicines to correct their acrimony, or as a means of suspending them in aqueous mixtures.

In the arts it is also used, especially in calico printing, to give the proper consistency to the cloth previous to the application of the mordaunts, and to prevent their running and mixing with each other. An annual consumpt of upwards of 12,000 cwt. of this gum is required in Britain, besides other gums of similar quality.

Gum Senegal is procured from a species of *acacia*, a native of Guinea. Its flowers are yellow, globular, and fragrant. The pods are brown coloured, and rounder, and smaller than those of *acacia vera*. On incisions being made in the bark of the tree, the gum exudes, but less plentifully than the gum Arabic. Gum Senegal resembles gum Arabic in all its qualities, but is rather inferior.

Tragacanth or Goat's Thorn *(astragalus tragacantha)*. Natural family *leguminosæ; diadelphia, decandria*, of Linnæus. This and some other species, particularly *a. verus*, yield the gum tragacanth of commerce.

The astragalus tragacanth, is a low, procumbent shrub, with a short, thick, branched stem, clothed with brown, rigid fibres, and beset with long sharp spines. The leaves are pinnated, consisting of about eight pairs of small, oblong leaflets, which are attached to a strong, spinous, persistent footstalk, or midrib. The flowers are large, papilionaceous, of a pale yellow colour, and terminate the branches in close clusters. The pod is two-celled, containing kidney-shaped seeds. It is a native of Asiatic Turkey, and the southern part of Europe, particularly Italy, Sicily, and Crete; and it flowers from May till July.

It was introduced into England in the time of Parkinson, where it thrives well, but does not produce any gum. Tournefort discovered it growing plentifully about Mount Ida. According to his observations, the gum exudes spontaneously towards the end of June, and in the following months, during which period the nutritious juice of the plant, thickened by the summer heat, bursts most of the vessels in which it is confined. This juice coagulates in threads, which make their way into the pores of the bark, through which being pushed forward by fresh juice they issue forth, and are at length hardened in the air, either in irregular lumps, or in long vermicular pieces bent into a variety of shapes. The best sort is white and semi-transparent, dry, but somewhat soft to the touch. It is considerably different in many of its properties from gum Arabic; one part of this diffused in one hundred parts of water, affords a fluid of the same consistency as one part of gum Arabic dissolved in ten parts of water. Water is, however, but an imperfect solvent of it, not forming the same intimate union with it as with other gums. When tragacanth is put into water, it slowly imbibes a great quantity, swells into a large volume, and forms a soft, but not fluid mucilage. On the addition of more water, and if the mixture be agitated, the gum will be more generally diffused throughout the liquor, which will appear turbid. If left at rest, the mucilage will again separate and subside; the supernatant water appearing limpid, and holding only a very small portion of the gum.

This mucilage differs from that of gum Arabic in being precipitated by sugar of lead, and the oxymuriate of tin, and not by silicated potass, or the oxysulphate of iron.

M. Billardier gives a somewhat different account from that of Tournefort. He says that he visited Mount Lebanon in August, the season when the gum is collected. He then found the species of astragalus which afforded it to be different from that figured and described by Tournefort. According to Billardier, the stem of the Cretan astragalus is blackish, that of Lebanon is yellow; the leaves of the first are downy, of the second they are smooth; the flowers of one are red, of the other of a pale yellow. From whence he infers, that there are two or more species of this plant which afford the gum. He also dissents from the opinion of Tournefort, who attributes the flowing of the gum to the contraction of the fibres of the bark, occasioned by the intensity of the solar heat, observing, that it is only during the night, or when the sun is obscured by clouds, that the gum issues from the plant, and that the same has been remarked at Crete.

Astragalus verus is a native of the north of Persia, and flowers in July and August. It is a shrub of two or three feet in height, with a stem about an inch thick, with many branches closely crowded together, and covered with imbricated scales and spines, formed from the petioles of the former year. The leaves, which scarcely exceed half an inch in length, are composed of from six to eight pinnæ, in opposite pairs, villous, stiff, and pointed. The flowers are small, yellow, and proceed from the axillæ of the leaves, with cottony brackets. The gum exudes in summer, more or less plentifully in proportion to the solar heat, in tortuous threads, which are allowed to dry on the plant before being collected. A great proportion of the gum gathered in Persia, is sent to India, Bagdad, Bassorah, and Russia. That which comes to Britain, is sent from Aleppo, packed in cases.

Gum tragacanth possesses the same demulcent qualities as gum Arabic; and from its greater viscidity, may in some cases be preferable.

It is also used in preparing cloths for receiving the dye, especially such mordants as are prepared with nitrous acid. Its use, however, is restricted in consequence of its high price. The annual consumpt in Britain is about 30,000 lbs.

A species of gum designated kuteera, was in 1802, and during a few previous years, imported in large quantities from India into Europe, under the mistaken opinion that it was gum tragacanth, which it so much resembled as to deceive many dealers. It was, however, at length ascertained that the kuteera was the product of the *sterculia urens*, a tree abounding in several parts of Oude, and the adjacent countries, but of quite a different species to the thorny bush which yields tragacanth.

It is found that this substance does not possess all the characteristics of gum, it being very imperfectly soluble, and possessing little of a glutinous nature; it is therefore inapplicable to the purposes for which tragacanth is used. On this dissimilarity being discovered, of course this new gum was supposed to be valueless, and many tons were for a long time lying at the East India Company's warehouse totally unsaleable. It might, however, be usefully applied to some other purpose. The natives of India make

many uses of it besides giving it to their horses as a medicine.

A patent has been recently taken out in London, for applying the mucilage extracted from the seed of the carob tree, commonly called St John's bread. This is of so strong a gummy consistency, that one pound of this is said to produce an equal effect with eight pounds of gum Senegal, and nine or ten pounds of gum Arabic.

The seeds, after being divested of their skins by the agency of sulphuric acid, are dried, and then ground in a mill, and the powder thus obtained is the mucilaginous matter.

Benzoin, or Benjamin Tree *(styrax benzoin)*. Natural family *ebenaceæ; decandria, monogynia,*

221.

Benzoin.

of Linnæus. This tree is a native of Sumatra. It is of quick growth, and attains a considerable height. The stem sends off many strong, round branches, which are covered with a whitish, downy bark. The leaves are oblong, entire, tapering to a point, smooth on the upper surface, and downy on the under; and they stand alternately upon short footstalks. The flowers are produced in bunches, and usually hang all on the same side, upon short, slender pedicles. The calyx is short, bell-shaped, and downy. The corolla is monopetalous, downy, and of a grayish colour. The fruit is a pulpy pericarp, containing one or two oval compressed nuts.

The tree begins to afford benzoin in the sixth year of its age, or when the trunk has acquired a diameter of seven or eight inches. The bark is then cut through longitudinally, or somewhat obliquely at the origin of the principal lower branches, from which the drug exudes in a liquid state; and by exposure to the sun and air, soon concretes, when it is scraped off from the bark with a knife or chissel. The quantity of benzoin which one tree affords, never exceeds three pounds; nor are the trees found to sustain the effects of these annual incisions, longer than ten or twelve years. The benzoin which issues first from the wounded bark, is the purest, being soft, extremely fragrant, and very white; that which is less esteemed, is of a brownish colour, very hard, and mixed with various impurities, which it acquires during its long continuance on the trees. There are three kinds distinguished according to purity and lightness of colour; the best being white, and the inferior of a dark or deep brown colour. In Arabia, Persia, and other parts of the East, the coarser kinds are consumed for fumigating and perfuming the temples, and for destroying insects. The benzoin found in the shops in this country, is in large brittle masses, composed partly of white, partly of yellowish, or light brown, and often also of darker coloured pieces. This resin has very little taste, impressing on the palate only a slight sweetness; but its smell, especially when rubbed or heated, is extremely fragrant and agreeable. It totally dissolves in rectified spirit of wine, the impurities excepted, into a deep, yellowish, red liquor; and in this state discovers a degree of warmth and pungency, as well as sweetness. It imparts to water also a considerable share of its fragrance, and a slight pungency: the filtered liquor gently exhaled, leaves not a resinous or mucilaginous extract, but a crystalline matter, amounting to one-tenth, or one-eighth of the benzoin. Exposed to the action of heat in a retort, it yields a quantity of a light semi-crystallized matter, which is benzoic acid. This has an acidulous taste, and all the peculiar odour of benzoin. Benzoin is supposed to possess little medicinal virtues, and is used chiefly to give a flavour to pectoral mixtures. It is employed in the preparation of perfumes.

Storax, or *Styrax Tree (styrax officinale)*. This is another species of the same genus, and is a native of Italy and the Levant. It usually attains the height of twenty feet. The stem sends off many strong branches, which are covered with a roughish bark of a gray colour. The leaves are broad, elliptical, entire, slightly pointed, smooth above, and underneath covered with a whitish down. The flowers are large, white, and disposed in clusters upon short peduncles, terminating the branches. The corolla is monopetalous, and divided into five lanceolate segments. The fruit is a nut, contained in a pulpy pericarp.

This tree was first cultivated in England by Gerard; and although it is indigenous to many of the southern parts of Europe, yet the resin which it produces is only to be obtained in perfection from trees of the same species growing in Asiatic Turkey. The storax issues in a fluid state from incisions made in the bark of the trunk, or branches of the tree; and as it was formerly the custom to collect and export this gum resin in reeds, it obtained the name of *calamite styrax*.

There are two kinds usually kept in the shops, one is in irregular, compact masses, free from impurities, of a yellowish, or reddish brown colour, and interspersed with whitish tears, some-

what like gum ammoniac, or benzoin; it is extremely fragrant, and readily melts with heat. The other kind is in large masses, very light, and bears no external resemblance whatever to the former, as it seems almost wholly composed of dirty saw dust, merely caked together by the resinous matter; and though much less esteemed than the purer kinds of storax, yet when freed from the woody part, it is said to possess more fragrance, and is superior to the other. It is readily dissolved in rectified spirits. It imparts to water in which it has been infused, a deep, yellow colour, a slight odour, and balsamic taste; by distillation it gives out more of its fragrance, but does not yield an essential oil. The spirituous solution gently distilled off from the filtered, reddish liquor, brings over with it very little of the fragrance of the storax, while the remaining resin is more fragrant than the finest storax in the tear. The pure resin distilled without addition yields, along with an empyreumatic oil, a portion of benzoic acid, similar to the flowers of benzoin.

Among the ancients storax was a common medicine, and was generally used in coughs, colds, asthma, and other affections of the chest. In modern practice, however, it is seldom employed, except like benzoin, with which, indeed, it is almost identical, as a pleasing perfume, and to give flavour to other medicines.

Cretan Cistus *(cistus creticus)*. Natural family *cistineæ; polyandria, monogynia*, of Linnæus. This handsome shrub seldom rises to any considerable height; it is covered with a dark coloured bark, and sends off several simple branches. The leaves are oblong, pointed, waved, rough, viscous, and stand in pairs upon short footstalks. The flowers are produced in succession at the extremities of the branches, in June and July. They are large, of a purplish, red colour, marked with dark spots at the base of each petal, and stand on short peduncles. The corolla is composed of five petals, large, round, pink coloured, and very evanescent. The seeds are contained in a round capsule.

This shrub, which is a native of Candia, and some of the islands of the Archipelago, was first cultivated in England by Miller, in 1731, and is now, along with several other species of the same genus, very generally cultivated as an ornamental garden shrub.

Almost all the species abound with a glutinous liquor, which exudes from the leaves in summer; and from the *cistus creticus*, the substance known under the name of *labdanum*, is collected. This is done in Candia by an instrument called there *ergastiri*, made in the form of a rake, to which several leathern thongs are fixed instead of teeth, and with which the leaves of the shrub are lightly brushed backwards and forwards, so that the fluid labdanum may adhere to the leather, from which it is afterwards scraped off with knives, and formed into regular masses for exportation. As this substance is observed to issue most copiously during the hottest weather, the method of collecting must be performed when the intensity of the sun's heat renders it a very laborious and troublesome employment. Three sorts of labdanum have been described by authors, but only two are now to be met with in the shops. The best, which is very rare, is in dark coloured masses, of the consistence of a soft plaster, growing still softer on being handled; the other is in long rolls, coiled up much harder than the preceding, and not so dark. The first has commonly a small, and the last a large admixture of fine sand, which in the labdanum examined by the French Academy, amounted to three-fourths of the mass. It is scarcely, indeed, to be collected pure, independently of designed abuses, the dust blown on the plant by winds, from the loose sands among which it grows, being retained by the tenaceous juice. The soft kind has an agreeable smell, and a highly pungent, bitterish taste; the hard is much weaker. Rectified spirit of wine dissolves nearly the whole of pure labdanum into a golden coloured liquor. On infusing labdanum in water, it impregnates the fluid considerably with its smell and taste; and in distillation with water, there comes over a fragrant, essential oil.

By the ancients, we are told that the *labdanon* was collected by combing the beards and thighs of goats who browsed upon the cistus, and to whose hair the drug was found to adhere; another method of gathering it was by throwing cords over those shrubs which produce it. This substance was formerly much employed as a medicine in coughs and affections of the chest; now, however, its use is confined to the composition of plasters, to be applied externally.

Balsam of Gilead *(amyris Gileadensis)*. Natural family *terebintaceæ; octandria, monogynia*, of Linnæus. This tree attains the height of fourteen feet. Its branches are numerous, spreading, and crooked. The wood is white, soft, and covered with a smooth, ash coloured bark. The leaves are small, few, commonly consisting of one pair of pinnæ, with an odd one

222.

Balsam of Gilead.

at the top. The pinnæ are sessile, inversely ovate, entire, and of a bright green colour. The flowers are scattered upon the branches, and are of a white colour; the calyx is permanent; the corolla consists of four white petals; the fruit is drupaceous, roundish, oval, opening by four valves, and containing a smooth nut.

According to Mr Bruce, this tree is a native of Abyssinia, growing among the myrrh trees behind Azab, all along the coast to the straits of Babelmandeb. It is said to have been early transplanted into the south of Arabia, and into Judea, one thousand years before the queen of Saba, who, according to Josephus, gave this tree among other presents to king Solomon.

Theophrastus, Dioscorides, Pliny, and even the Arabian physicians, supposed this balsam to be the produce of Judea only; and hence it seems to have received the name of balsam of Judaicum, or balm of Gilead.

There is another species nearly allied in character, the *amyris opobalsamum*, which produces the balsam of Mecca. This species has pinnated leaves, with sessile leaflets. It grows near Bederhunin, a village between Mecca and Medina, in a sandy, rocky soil, confined to a small tract about a mile in length, and attains the height of fifteen feet.

The balsamic juice of those trees issues spontaneously from fissures in the bark; but it is generally obtained by artificial incisions. The balsam now imported into Europe is reported to be principally collected between Mecca and Medina. "The bark," says Mr Bruce, "is cut by an axe when the juice is in its strongest circulation in July and August, and the beginning of September. It is then received into a small earthen bottle, and every day's produce gathered and poured into a larger, which is kept closely corked. The juice, when first received into the bottle or vase, from the wound from which it issues, is of a light yellow colour, apparently turbid, in which there is a whitish cast, which, I apprehend, are the globules of air that pervade the whole of it in its first state of fermentation; it then appears very light upon shaking. As it settles and cools, it turns clear, and loses that milkiness which it first had when flowing from the tree into the bottle. It then has the colour of honey, and appears more fixed and heavy, than at first. After being kept for years, it grows of a much deeper yellow, and of the colour of gold. I have some of it which I got from the Cadi of Medina, in 1768, it is now still deeper in colour, full as much so as the yellowest honey. It is perfectly fluid, and has lost very little either of its taste, smell, or weight. The smell at first is violent, and strongly pungent, giving a sensation to the brain, like that of volatile salts when rashly drawn up by an incautious person. This lasts in proportion to its freshness; for being neglected, and the bottle uncorked, it quickly loses this quality, as it probably will at last by age, whatever care is taken of it." The balsam which one tree yields is very small, and the collection of it is tedious and troublesome; hence, it is so very scarce, that the genuine balsam is very rarely, if ever, exported in a commercial way. The best balsam, according to Alpinus, is at first turbid, and white, of a very strong pungent smell, like that of turpentine, but much sweeter, and more fragrant, and of a bitter, acrid, astringent taste; on being kept for some time, it becomes thin, limpid, light, of a greenish hue, and then of a gold yellow, after which it grows thick, like turpentine, and loses much of its fragrance. Some compare the smell of this balsam to that of citrons; others to that of a mixture of rosemary and sage flowers. The chief mark of its goodness is said to be founded on this, that when dropped on water, it spreads itself all over the surface, forming a thin pellicle, tough enough to be taken up on the point of a pin, and at the same time impregnating the water with its smell and flavour. This last is not, however, to be depended upon, as several other resinous fluids and oil of juniper produce the same appearances.

This article was highly valued even among the earliest races of mankind. We read in the scriptures, that balm and myrrh were carried by the Ishmaelites to Egypt, and this formed one of the earliest articles of trade among the Eastern nations. By them it was esteemed not only for its perfume, but for its supposed medicinal virtues, which latter were estimated very highly. The sacred prophet exclaims, "Is there no balm in Gilead? Is there no physician there? Why then is not the health of the daughter of my people recovered?" Even in the present day, its medicinal virtues are highly extolled in the East; and it is in so much request, that the genuine balm is to be procured with great difficulty.

In Turkey, it is not only in high esteem as a medicine, but also as an odoriferous ingredient, and a cosmetic for the skin. Lady Mary Wortley Montague, mentions that she tried its effects as a cosmetic, and found that it was of so stimulating a nature, that the day after using it her face became red and swollen, which affection continued for three days.

In modern European practice it is, however, very lightly esteemed, being placed upon a level with the other turpentine balsams.

Elemi Tree *(amyris elemi)*. This tree is of the same family as the above, but is a native of Carolina and South America. In dry weather, and especially at full moon, incisions are made in the bark, from which a resinous juice flows, and is left to harden in the sun. It comes to this country in long, roundish cakes, generally wrapped up in flag leaves. The best

is softish, somewhat transparent, of a pale, whitish, yellow colour, inclining a little to green, of a strong, not unpleasant smell, resembling somewhat that of fennel. It is readily soluble in alcohol, and appears to be a composition of a resin and essential oil. At present it is held in little estimation in medicine; but it is used sometimes for the composition of varnishes.

MASTIC TREE *(pistacia lentiscus)*. Natural family *terebintaceæ; diœcia, pentandria*, of Linnæus. This tree, which seldom exceeds a foot in diameter, rises ten or twelve feet in height. It is covered with a smooth brown bark, and towards the top sends off numerous branches. The leaves are regularly pinnated, and consist of several pairs of narrow, ovate, opposite pinnæ, closely attached to the common footstalk, which is winged, or supplied with a narrow, foliaceous expansion. The male flowers are placed in an open catkin, and the female upon the common peduncle, in alternate order. The flowers appear in May; and the fruit, which is an oval, smooth nut, ripens in August.

This tree is a native of the south of Europe, and the Levant. According to Evelyn, it was introduced into Britain in 1664; but in this country it is of slow vegetation, and seldom healthy enough to give a complete idea of the plant in its natural situation; nor does it here, with the diminished solar heat, afford any gum.

Mastic is a resinous substance collected in the form of tears; it is of a very pale yellow colour, having but little smell, and scarcely any taste. It forms the basis of several dyeing varnishes, is one of the ingredients used in fumigations, and is considered to be efficacious in promoting a healthy state of the mouth: for this latter purpose it is held in much esteem by the Turks, Greeks, and all the people of the Levant, who constantly chew it. Hence it takes its name; mastic being derived from *masticare*, to masticate. The women of Scio, Smyrna, and Constantinople, have almost always a piece of it in their mouths.

This is the most celebrated production of the island of Scio, and of so much importance is it considered there, that the inhabitants of the villages that furnish it, had, when under their Turkish masters, many peculiar privileges. They acknowledged no other chief than the *aga*, or lord who farmed that production; they were exempt from contributing their labour gratuitously on public occasions, being obliged only to convey the mastic to the town, and to furnish beasts of burden to this aga when he travelled about the villages in order to collect it. "We had an opportunity," says M. Olivier, "of seeing the aga on his tour, preceded by military music, followed by several *tchocadars*, and surrounded by a great number of villagers, eager to attend on him. Had we not been previously informed, we should much rather have taken him for a military commander, than a simple farmer of taxes.

In order to obtain the mastic, numerous incisions are made in the trunk and principal branches of the tree, during five days in the middle of July. A liquid juice gradually exudes from these incisions; this thickens by exposure to the air so immediately, as mostly to adhere to the tree in the form of drops; but when very abundant, it falls to the ground before it becomes a concrete substance. The former kind is most esteemed; it is detached from the bark with a sharp iron instrument: those persons who are careful in collecting it, spread cloths on the ground under the trees, that the juice which falls may not be injured by coming in contact with the earth. The first gathering lasts during eight successive days, after which fresh incisions are made in the tree, and they are untouched until the 25th of September. Then the second gathering begins, and it is not allowed to cut the trees any more that season; but the mastic, which continues to run, is gathered until the 19th of November, on the Monday and Tuesday of every week, after which time it is forbidden to gather this production.

The culture of the lentisk is simple, and attended with little trouble; it consists much more in cleansing than in turning the soil. The cultivators do not prune this tree, but, on the contrary, endeavour to prevent the stem from growing in a handsome form, as it has been found from experience that the lentisks which trail, yield much more mastic than those the stems of which are straight and shooting.

It may readily be imagined that all the Greeks in the island would gladly have become cultivators of the lentisk, by which they would gain exemption from the petty and harrassing tyranny to which others were constantly subjected; but while it was prohibited under the severest penalties to offer the mastic for sale to any but the aga who farmed it, the cultivation of the lentisk was forbidden out of the limits traced by the government.

A Turk had recourse to an ingenious stratagem by which he evaded the law, and hoped to obtain some of the advantages acquired by the cultivation of mastic. He grafted the lentisk on young turpentine trees, and had the satisfaction of finding that these grafts succeeded perfectly well. To his astonishment, however, a few years afterwards, on making incisions on the trees, a liquid flowed, which combined with the odour and other qualities of the mastic the unchanging fluidity of turpentine.

The quantity of mastic imported into this country, and retained for home consumption, in 1830, was 13,644 lbs. It is admitted under a duty of 6*s*. per cwt.; its present price varying

from 4*s.* 6*d.* to 5*s.* 6*d.* for the same quantity.

A small quantity of inferior mastic is brought from Egypt.

Mastic, like all other resins, is soluble in alcohol and oil of turpentine, and is scarcely acted upon by water; it becomes by mastication soft and tough, like India-rubber. A small part of it does not dissolve in a spirituous menstruum, and this portion much resembles caoutchouc in its properties.

Turpentine Tree *(pistacia terebinthus)*.* This is another species of the same genus as the foregoing; but it attains a much larger height, with numerous spreading branches. The leaves are pinnated, oval, and lanceolate; the flowers are essentially the same as the other species. It is a native of Barbary and the south of Europe, and has been cultivated in Britain for about a century; and if planted against a wall, bears our winters very well. The Cyprus or Chian turpentine is procured by wounding the bark of the trunk of this tree in several places during the month of July, leaving a space of about three inches between each wound; from these the turpentine issues, and is received upon stones which are placed at the bottom of the tree for this purpose, and upon which it becomes so much condensed by the coldness of the night, as to admit of being scraped off with a knife in the morning, which is always to be done before the sun rises. After this, in order to free it of all extraneous mixture, it is again liquified by the sun's heat, and passed through a strainer when it is fit for use. The best Chian turpentine is generally about the consistence of thick honey, very tenacious, clear, and almost transparent; of a white colour, inclining to yellow, and a fragrant smell; moderately warm to the taste, but free from acrimony and bitterness. The quantity of this turpentine produced from each tree, is very inconsiderable, not more than two pounds being procured from six large trees of sixty years of age. In consequence of its scarcity, it is not unfrequently adulterated with other turpentines.

Resin and essential oil of turpentine are, however, procured abundantly from the pine tribe; and these trees afford the turpentine of commerce, and that also used in medicine.

Oil of turpentine is a powerful stimulant, both taken internally, and used externally on the skin. It is employed as a purgative, diuretic, anthelmintic, and antispasmodic; and externally for the cure of rheumatism, and local pains and swellings.

Balsam of Tolu *(Toluifera balsamum)*. Natural family *lomentaceæ; decandria, monogynia*, of Linnæus. The tree which yields the balsam of Tolu is a native of South America, and grows to a considerable height. It sends off numerous

223.

Balsam of Tolu.

large branches, and is covered with a rough, thick, grayish bark. The leaves are ovate, entire, pointed, alternate, of a light green colour, and stand upon short footstalks. The flowers are numerous in lateral racemes; the calyx bell-shaped; the corolla five-petalled, and whitish; the fruit a round berry. It grows in Tolu, a province of Spanish America, and the balsam is exported in little gourd shells. This is obtained by making incisions in the bark of the tree; as the gum flows out it is collected in spoons of black wax, and then deposited in vessels, where it hardens. This substance is of a reddish yellow colour, somewhat transparent, and of a thick consistence. Its smell is fragrant, resembling that of lemons; its taste is warm and sweetish, and on being chewed, it adheres to the teeth. Thrown into the fire it immediately liquifies, takes flame, and disperses its agreeable odour. It does not dissolve in water, yet if boiled in it for two or three hours in a covered vessel, the water receives its odoriferous smell. With the assistance of mucilage it unites with water, so as to form a milky solution. It dissolves entirely in spirit of wine, and easily mixes with distilled oils, but less easily with those of the expressed kind. Distilled without any addition, it produces not only an empyreumatic oil, of a pale dark colour, but sometimes also a small portion of acidulous flakes, resembling flowers of benzoin.

In modern practice, this balsam is not employed for any decided virtues it may possess, but is chiefly used to impart a flavour, and a slight stimulating quality to pectoral medicines. It is used in tincture, as a syrup for these purposes.

Copaiva Tree *(copaifera officinalis)*. Natural family *leguminosæ; decandria, monogynia*, of

* This tree was shortly alluded to under another head, p. 388.

Linnæus. This is an elegant tree, attaining a considerable height, and dividing into numerous branches. The bark is rough, and of a dark brown colour; the leaves are pinnated, consisting of four pair of pinnæ, large, ovate, pointed, somewhat narrowed on one side, and placed upon short footstalks. The flowers are small, of a whitish hue, and produced in terminal, branched spikes. The fruit is an oval pod, of two valves, pointed with part of the remaining style. It contains one egg-shaped seed, involved in a berried arillas.

224

Balsam of Copaiva.

This tree is a native of Brazil, and some of the neighbouring islands of South America; and it is said* to have been discovered in Terra Firma, in large woods, with those trees which afford several other balsams, as those of Tolu and Peru. The balsam of copaiba, or copaiva, is the resinous juice of this tree, obtained by making incisions near the base of its trunk, extending not only through the bark, but into the substance of the wood, whence the balsam immediately issues, and at the proper season flows in such abundance, that sometimes in three hours twelve pounds have been procured. The older trees afford the best balsam, and yield it two or three times in the same year. The balsam supplied by the young and vigorous trees, which abound with the most juice, is crude and watery, and is therefore accounted less valuable. While flowing from the tree, this balsam is a colourless fluid; in time, however, it acquires a yellowish tinge, and the consistence of oil; but though by age it has been found thick, like honey, yet it never becomes solid, like other resinous fluids. Sometimes an inferior sort is met with, thick, and not at all transparent, and generally having a quantity of turbid, watery liquor, at the bottom. This is probably either adulterated by the mixture of other substances, or has been extracted by decoction from the bark and branches of the tree, its smell and taste being much less pleasant than the genuine resin. The pure balsam has a moderately agreeable smell, and a bitterish, biting taste, of considerable duration in the mouth. It dissolves entirely in rectified spirit, especially with the addition of a little alkali, which solution has a very fragrant smell. Distilled with water it yields nearly half its weight of a limpid, essential oil; and in a strong heat, without addition, a blue oil.

This, like the other balsams, is nearly allied to the turpentines. It is reckoned a useful and powerful medicine in affections of the mucous and serous membranes in pulmonary complaints, where there is a cough and copious discharge from a relaxed state of the membranes, and in weakness and ulcerations of the urinary organs. It is also a powerful diuretic, and has been employed in dropsies. Its effects, however, are rather irritating and heating, and on this account its use is less advisable in diseases of an inflammatory tendency. It is of a laxative nature, and has been found useful in certain cases of piles, and weaknesses of the intestines. The dose is from one to two, or three tea-spoonfuls. As it proves nauseous to most palates, it is often formed into an emulsion with pounded almonds, or a thick solution of gum Arabic.

Peru Balsam *(myroxylon Peruiferum). Decandria, monogynia*, of Linnæus. This tree is a native of the warmest parts of South America, and is remarkable for its elegant appearance. Every part of it abounds with resinous juice; even the leaves are full of transparent resinous points, like those of the orange tree. The balsam, as brought to this country, is commonly of the consistence of thin honey, of a reddish brown colour, inclining to black; an agreeable aromatic smell, and a very hot, biting taste. It is said to be obtained by boiling the cuttings of the twigs in water, and skimming off with a spoon the balsam which swims on the top. By incision the tree yields a much more fragrant white, or colourless balsam, which, when thickened by the heat of the sun, forms the red or dry balsam of Peru; but it is very rarely used in Britain, and almost never is to be met with in the shops. Peruvian balsam consists of a volatile oil, resin, and benzoic acid; it is entirely soluble in alcohol, and in essential oils: water dissolves part of the benzoic acid, and fixed oil combines with the resin. It may be suspended in water by trituration with mucilage, or yolk of egg. It is a warm, aromatic medicine, considerably hotter, and more stimulating than copaiva, and is used in similar complaints. It is also used sometimes as an external application to foul and indolent ulcers, and in rheumatic pains.

Opoponax, or Rough Parsnip. Natural family *umbelliferæ; pentandria, digynia*, of Linnæus. This plant belongs to the parsnip genus. The root is perennial, thick, fleshy, and tapering like the garden parsnip. The stalk is strong, branched, rough towards the bottom, and rises to the height

* Woodville's Medical Botany.

of seven or eight feet. The leaves are pinnated, consisting of several pairs of pinnæ, which are oblong, serrated, and towards the base appear unformed on the upper side. The flowers are small, of a yellowish colour, and terminate the stem and branches in flat umbels. The fruit is elliptical, compressed, and divided into two parts containing two flat seeds, encompassed with a narrow border. It is a native of the south of Europe, and flowers in June and July. It was cultivated in this country in 1731, by Miller, who observes that its roots are large, sweet, and accounted very nourishing, and recommends it for cultivation as an esculent vegetable. It bears the cold of any climate well, and sometimes matures its seeds, its juice also manifesting some of those qualities for which it was at one time so celebrated; but it is only in the warm regions of the East, and where this plant is a native, that its juice concretes into the gummy, resinous drug, called opoponax, which means "all juice, and a cure for all complaints."

This substance is obtained by means of incisions made at the bottom of the stalk of the plant, from which the juice gradually exudes, and hardens into a gum. That which is imported from Turkey and the East Indies, is in the form of little round drops or tears; but more commonly in irregular lumps, of a reddish yellow on the outside, with specks of white, internally of a paler colour, and frequently variegated with large white pieces.

This gum resin has a strong, disagreeable smell, and a bitter, acrid, somewhat nauseous taste. It readily mingles with water, by trituration into a milky liquor, which, on standing, deposits a portion of resinous matter, and becomes yellowish. With rectified spirits it forms a gold coloured tincture, which tastes and smells strongly of the gum.

Formerly, this substance was much employed by physicians, and esteemed for its purifying, cleansing, and aperient virtues; but as it was commonly prescribed in conjunction with other medicines, its real effects are not very well ascertained. More modern experience has nearly altogether discarded it as a medicine of little power. Dr Cullen classes it with the antispasmodic or nervous drugs, and prescribed it in hypochondriacal affections, uterine diseases, and asthma, connected with a sluggish habit of body. It still continues a famous medicine in the East, and is reckoned a cure for all diseases.

GALBANUM *(bubon galbanum)*. Natural family *umbelliferæ; pentandria, digynia*, of Linnæus. This is a perennial plant, a native of Africa. The stem is shining, smooth; the leaflets ovate, wedge-shaped, acute, and finely serrated on the edges. The umbels of the flowers are few, the seeds shining. The whole plant abounds with a milky juice, which sometimes spontaneously exudes from the joints of the old plants; but is more frequently obtained by cutting them across some inches above the root. The juice which flows from the wound soon hardens, and forms the gum galbanum, which comes to this country from Syria and the Levant. The best sort consists of pale coloured pieces, about the size of a hazel nut, which upon being broken, appear to be composed of clear white tears, of a bitterish, acrid taste, and a strong peculiar smell. But it most commonly occurs in agglutinated masses, composed of yellowish, and reddish, clear, white tears, which may be easily torn asunder; of the consistence of firm wax, softening by heat, and becoming brittle by cold, and mixed with seeds and leaves.

Galbanum is almost entirely diffusible in water, but the solution is milky; nor does wine or vinegar dissolve it perfectly. When distilled with water, a considerable quantity of essential oil is obtained, in the proportion of six drams of oil to one pound of the gum.

The ancients were acquainted with this substance; and Pliny describes it under the name of *bubonion*. It is recommended by the older physicians in pectoral complaints, and externally as a cure for swellings of the glands, and to promote their suppuration.

INDIAN RUBBER TREE *(siphonia elastica)*. Natural family *euphorbiaceæ; monœcia, monodelphia*, of Linnæus. This is a large, straight tree, growing to the height of fifty to sixty feet, at the upper part sending off numerous branches, covered with rough bark. The leaves are placed on long footstalks; they are ternate, elliptical, and somewhat pointed; entire, veined, smooth, and on the under side whitish. The flowers are male and female on the same tree, small, and stand on dividing racemes at the end of the branches. The capsule is large, woody, three-celled, and contains oval spotted seeds. This tree is a native of South America, and grows abundantly in the woods of Guiana, in the province of Quito, and along the borders of the river Amazon, in the kingdom of Mexico. The juice of this tree furnishes the well known substance called Indian rubber, or caoutchouc.

225.

Caoutchouc.

This substance is, however, furnished by other trees, as: *exœcaria, agallocho, hippomane, mananella, hura crepitans, sapium aucuparium, plukenetia volubilis, jatrophas mabœa*, and *omphaleus*.

This substance was little known in Europe till the voyage of M. Condamine, in 1750, into the interior of South America, where he examined the tree; and on his return laid a description of it, and the manner of preparing the gum, before the French Academy. The mode in which the juice is obtained by the natives, is by making incisions through the bark of the lower part of the trunk of the tree, from which the fluid resin issues in great abundance, appearing of a milky whiteness as it flows into the vessel placed to receive it, and into which it is conducted by means of a tube or leaf, fixed in the incisions, and supported with clay. On exposure to the air, this milky juice gradually thickens into a soft, reddish, elastic resin. To suit the different purposes for which it is employed in South America, the caoutchouc is shaped into different forms; but it is commonly brought to Europe in that of pear-shaped bottles, which are said to be formed by spreading the juice of the siphonia over a proper mould of clay, and as soon as one layer is dry another is added, till the bottle be of the thickness desired. It is then exposed to a dense smoke, or to a fire, until it becomes so dry as not to stick to the fingers, when, by means of certain instruments of iron or wood, it is ornamented on the outside with various figures. This being done, it remains only to pick out the moulds, which is easily effected on their being first softened with water.

Caoutchouc is insoluble, and consequently impervious to water, alcohol, and most fluids. Some of the essential oils dissolve it; but its elasticity and other properties are thereby lost. Two solvents have been discovered for it, ether and naphtha, or essential oil of tar. The natives of South America have long been in the habit of using this juice for a variety of purposes. They collect it chiefly in the rainy season, because, though it exudes at all times, it flows then most abundantly. The inhabitants of Quito prepare a kind of cloth of it, which they apply to the same purposes as the Mackintosh fabrics, so common now in this country.

They also form it into flambeaux, which give a beautiful light, and emit an odour which is not unpleasant to those who are accustomed to use them; but Europeans are annoyed by the fœtid smell which they diffuse. One of them an inch and a half in diameter, and two feet long, will burn during twelve hours.

Though not used directly in medicine, caoutchouc is found of essential service for the construction of several medical instruments, for which its softness, pliancy, and its power of resisting the various fluids of the body, renders it extremely appropriate.

CHAP. LII.

GARDEN FLOWERS—HYACINTH, TULIP, &c.

We have hitherto treated of vegetables useful to man, it remains to consider those which are peculiarly adapted for ornament. Almost every vegetable production has an aspect of beauty, and no ornaments can exceed those which the generality of flowering plants possess. Whether we consider the splendour, variety, and delicacy of their colour, the symmetry and minute detail of their proportions; the gracefulness of single simple form, or the gorgeous luxuriance of their grouped masses. If to this we add the delicious odour which they constantly and spontaneously diffuse, we need not wonder that flowers should be universal favourites, and that we should find them ornamenting the humblest cottage as well as the proudest palace.

By long and judicious cultivation, garden flowers undergo as remarkable changes as take place so strikingly in culinary vegetables. They increase in size, in depth, and variety of colour, and even change their forms. One of the most remarkable changes is that of their becoming what is called double. That is, the number of petals of the corolla increase many fold, as in the rose, and anemone, while the stamens and pistils, or organs of fructification, become almost or entirely obliterated, or converted into petals. To many tastes, perhaps, the simple and appropriate forms of the native flowers are more beautiful than this artificial monstrosity, yet it cannot be denied, but that the tints and luxuriant aspect of many flowers are decidedly improved by cultivation. Hence has arisen an artificial standard, among florists, of judging of flowers, which has been called the "canons of criticism." As suited for every day domestic ornaments, flower gardens, or plots, or borders, should be situated near the house, so as easy access may be obtained to them, or if not closely adjoining to the house, they may be placed so as to be seen from the windows. A south situation, or one inclining to the south-west, south-east, or east, is most desirable. When the space is limited, horizontal or gentle sloping borders will be found most convenient, while on the other hand, if the grounds are more extensive, a waved irregular surface will afford the greatest scope for taste in arrangement. The surface should be rather elevated, not low, sufficiently sheltered from the winds, yet open and free to the sun, not overshadowed or covered with trees, or other high foliage. A few elegant

shrubs, and one or two trees, may be scattered through the scene for the purposes of shelter and shade, but in general most of either of these two last are injurious to the proper culture of flowers. Sometimes the evergreen hedge will produce all the shelter requisite.

The subsoil should by no means be wet. Flowers, in general, thrive well in a common garden soil, a foot to eighteen inches deep, not either too rich, or too light and gravelly. For some kinds, however, a deep moist soil, and for others, a light arenaceous is preferable. Bulbous flowers, in general, do best in light sandy earth, though some require a stronger and richer soil. The primrose tribe *(primula)* require a loamy earth, heath plants a mixture of moss earth. The spaces between the flower beds may either be of turf, or sandy gravel, or paved with flags or bricks. The plants are arranged in mingled flower borders, partly according to their size, and partly according to colour. The tallest are planted in the back part, those of middling size occupy the centre, and those of humble growth are planted in front. The beauty of a flower border, when in bloom, depends very much on the tasteful disposition of the plants with regard to colour. By intermingling plants which flower in succession, the beauty of the border may be prolonged for some weeks; groups of plants of the same species, all in flower at the same time, have also a tasteful effect. A supply of water is essential to an artificial cultivation of flowers; where a pond or reservoir can be introduced into the flower garden, it will not only add to the beauty, but to the facility of cultivation. Many aquatic plants of great beauty may, by this means, be also cultivated. Herbaceous flower plants are put into the ground generally in spring or autumn, but any perennial plant may be safely removed after it has done flowering, or produced seed. Biennials or annuals may be planted at almost any season, before they have begun to throw up flower stems. Biennials, however, are generally sown early in autumn, in the flower garden nursery, and transplanted either late in the same season, or early in the following spring to where they are to flower. Annuals are commonly sown in spring, where they are finally to remain, but many species grow much stronger when sown in autumn. Some attention is also requisite to manage the flower garden to perfection. As the stalks of flowering plants shoot up they generally require thinning and props for support, and the blossom both of plants and shrubs no sooner expands than it begins to wither, and must be cut off unless as in some instances they are to be left for the beauty of their fruit. Weeding, watering, stirring the soil, and trimming the grass, and sorting the gravel walks, are all necessary for neatness and the proper growth of the plants. Every two or three years the perennial flowers should be taken up and reduced in size, and the beds or borders trenched, adding short manure completely rotted. After the lapse of several years, if it can be conveniently managed, the upper soil should be removed, and replaced by fresh loamy mould. Most flowers thrive well in fresh common loam without manure; and to such as require a deep rich soil, manure may be added at the time of trenching, or changing the soil. Peat earth, sand, clay, and lime may also be added to such plants as require particular soils.

Many tender plants and shrubs growing in the open air require protection during winter. Alpine plants require protection from cold dry winds, and this may be done by covering them with snow, and thus imitating their natural condition; or in absence of this, head glasses or frames are to be put over them in winter, and screens or shades to keep them from the summer heat. The roots of many plants require protection from frost, and this may be done by covering them several inches thick with ashes, rotten tan refuse, or litter; mats or portable glass cases will protect tender plants from rain, high winds, and hail stones. Great care is necessary to protect plants placed in pots from frost, and this is done by plunging them in dry soil, tan, or sand. Climbing plants require to be supported by poles or rods. All flies, caterpillars, snails, slugs, and such vermin must be destroyed, and no plan is more efficacious for this purpose, in the flower garden, than carefully hand-picking the plants. Among insects the different species of plant lice *(aphides)* are the most insidious and destructive.

Flowers may be preserved for a considerable time fresh after they have been cut from the plant by immersing the cut ends in water, moist earth, or sand, or moistened moss. They may also be revived when partially withered, by sprinkling them with water, and putting them under a bell glass or inverted flower pot. If this fails, immerse their ends in water heated to 80°, or sprinkle them with spirit of wine, or ether; flowers, when newly transplanted either into the ground or into pots, require a large supply of water, and to be shaded from the sun's rays for several days until they fully take root in their new position.

Besides herbaceous flower plants, there are a variety of shrubs and trees, both indigenous and exotic, which are conducive to ornament. We shall first treat of the herbaceous class.

The Hyacinth, *hyacinthus orientalis*. Natural family, *asphodeleæ; hexandria, monogynia* of Linnæus. This plant is a native of the Levant, and grows in abundance about Aleppo and Bagdad. It obtained its name from the Grecian youth Hyacinthus, who was fabled to have been slain

by Apollo, and changed to this flower. The root is a tunicated bulb, the leaves are broad and green; the flower-stalk rises from the centre, the corolla is funnel-shaped, and half cleft into six portions, the flowers point in all directions around the scape, which is erect. It appears to have been first cultivated, as a garden flower, by the Dutch, most probably about the beginning of the sixteenth century, soon after the revival of commerce in the west of Europe, when that enterprising nation began to trade on the eastern shores of the Mediterranean and the Archipelago. In Britain it was cultivated by Gerard in 1596. The hyacinth is one of the most esteemed of garden flowers. It is not only graceful in form, but brilliant, beautiful, and varied in colour, and possesses an odour little inferior to the carnation. It bears the climate of Britain well, and is of very easy culture. In its native country it flowers in February, here in March and April.

There are innumerable varieties of this flower. Gerard mentions the single and double blue, the purple, and the white. In 1629, Parkinson enumerates eight varieties, while the Haerlem gardeners distinguish not less than 2,000, and generally publish catalogues of them from year to year. As the taste or rage for this flower has at present abated, the Dutch and English catalogues contain only a few hundred varieties with names. They are arranged as double blues, whites, reds, and yellows, and single varieties of the same colour. The blue and red colours are the most common, the yellow most rare. At first the single hyacinth only was cultivated, but about the beginning of the last century attention was paid to double flowers by Peter Voerhelm, whose first double flower he called Mary, but which is now lost; his third flower he called the king of Great Britain, which is now looked upon as the oldest double hyacinth. It was held in such esteem at one time, that the usual price for a single bulb was 1,000 florins, or £100 sterling. Up to the middle of last century the greatest attention was paid at Haerlem to raising new sorts of double flowers, and for a particular root £200 have not unfrequently been given. Since that period, however, the taste for this and other bulbs has considerably declined, so that at present there are few sorts that exceed £10; the average price is from one to ten shillings a bulb for the fine sorts, and what are called the common mixtures are sold from £2 to £3 a hundred. To preserve these varieties requires much care and management. Under bad treatment a variety degenerates in two or three years; in Holland some have been preserved nearly a century.

The criterion or qualities requisite in a fine double plant are as follows. The stem should be strong, tall, and erect, supporting the numerous large bells, each supported by a short and strong peduncle, or foot-stalk in a horizontal position, so that the whole may have a compact pyramidal form with the crown or uppermost flower perfectly erect. The flowers should be large and perfectly double, that is, well filled with broad bold petals appearing to the eye, rather convex than flat or hollow. They should occupy about one half the length of the stem. The colour should be clear and bright, whether plain red, white, or blue, or variously intermixed and diversified, the latter giving additional lustre and elegance to this beautiful flower. Strong bright colours are, in general, preferred to such as are pale.

Hyacinths are propagated by seed, in order to obtain new varieties, and by offsets for continuing approved sorts. The seed should be selected from the best specimens of plants, such as have strong straight stems, and a regular well formed pyramid of bells, not perfectly single, but rather approaching to double. The seed should not be gathered till it is perfectly black. It is to be sown in the latter end of October, or the beginning of March, about half an inch below the surface of the soil, in a deep box filled with good garden mould mixed with sand. It requires no watering, and nothing but to be kept clear of weeds and frost till it has remained in the ground two years. On the approach of winter it must then have an additional stratum of the compost placed upon it about half an inch thick, and in the third year, in the month of July, the roots may be taken up, dried, and treated in the same manner as large bulbs or offsets. Some of the roots will flower the fourth year, one half of them the fifth, and the whole in the sixth. The cultivator generally thinks himself fortunate if one half of the plants that first appeared are in existence at this period, and if he can at least find one flower in five hundred deserving a name or place in a curious collection, he may rest perfectly content. Offsets are to be separated from the parent bulb, and planted out separately in the beginning of October, in an open space, in rows of about two inches deep, upon a bed raised about six or eight inches above the common level. The soil should be sandy and well pulverized; it is also advisable to elevate the bed somewhat in the middle so as to throw off the rain. The surface of the bed should be strewed occasionally, and kept free from weeds, and protected from severe frosts. The offsets will blossom weakly the second year, but in the third tolerably strong.

Of the full grown roots, those which have attained the age of four or five years bloom stronger in this country than any other. After this they generally decline, either by dividing into offsets, or diminishing in size and strength, but in Holland, perhaps owing to the peculiari-

ties of the soil and climate, the same bulb has been known to produce blossoms twelve or thirteen times, nor is it ever known to die merely with age. The bed on which they are to be placed should have a dry and airy sheltered situation; two feet of the surface soil should be taken away, and the inferior portion trenched to the depth of nine inches. The earth above is to be replaced with a compost of one-third coarse sea or river sand, one-third fresh earth, and one-fourth rotten cow dung, at least two years old, and the remainder earth of decayed leaves. This compost is to be placed in a sloping direction towards the sun. The roots are to be planted from the middle of October to the middle of November. On planting the roots, the surface of the bed should be covered with a little fresh sandy earth about an inch thick, raked perfectly smooth, and have the exact situation for every bulb marked upon it regularly, mingling the colours of red, and blue, and white, the yellows being classed with the latter. On planting the roots they should be surrounded with a little clean sand to prevent the earth adhering too closely to them, the whole are then to be covered with fresh sandy earth from three to four inches deep, according to the size of the bulb. The bed is to be protected from severe frosts or heavy rains by some covering. The plants begin to show their flowers about the beginning of April.

Those which thus blow early should be sheltered from the influence of the sun, for if too much sun falls on the flower, it bleaches and tarnishes the colour, particularly the red and blue varieties. By judicious shade this is not only prevented, but the flower is kept back so that it will be in full bloom with others which come out later. It is necessary to afford support to the stems, and this is done by inserting small sticks or wires, painted green, immediately behind the bulbs, either in an erect position, or leaning a little backwards, to which the stems are to be rather loosely tied with small pieces of green worsted as soon as they begin to bend, or are in danger of breaking with the weight of the bells. This operation must be repeated as the stems advance in height. When the greater part of the bed comes into blow, a covering or awning should be stretched over the whole, so as to protect the flowers from the too great influence of the sun, and the effects of wind and rains. This awning should, however, be so constructed as to fold up, or be opened at the top so as to allow air and the tempered influence of the sun in slightly clouded weather, and in the mornings and evenings. The bed never requires to be watered at any period, the natural rain which falls being sufficient after the time of planting both for the roots and the flowers. After the bloom is over, the dryer the plants are kept the better. As this sheltering, however, has a tendency to weaken the bulbs, it should not be continued more than a couple of weeks at most, and as soon as the full blow begins to decline the bed should be again exposed to the full action of the sun and air. In Holland, about three or four weeks after the bloom, when the plants begin to assume a yellowish decayed appearance, they take up the roots, and cut off the stem and foliage close to or within half an inch of the bulb, but leave the fibres attached to it. They then place the bulbs again on the same bed sidewise, with their points towards the north, and cover them about half an inch deep with dry earth or sand in the form of a ridge, or little cover over each. In this state they remain about three weeks longer, and dry or ripen gradually, during which time as much air is admitted as possible, but the bed is preserved from heavy rains and too hot a sun. At the expiration of this period the bulbs are taken up, and their fibres, which are become nearly dry, gently rubbed off. They are then placed in a dry room for a few days, and are afterwards cleared from any soil that adheres to them; their loose skins are taken off, with such offsets as may be easily separated. When this dressing is finished, the bulbs are wrapped up in separate pieces of paper, or buried in dry sand, where they remain till the return of the season of planting. An easier though not so safe a practice is to keep the bed airy and rather dry for about two months, till the stems and foliage appear nearly dried up, or consumed. The bulbs are then to be taken up, cleaned from the fibres and soil, and preserved in sand or papers. The bulbs should be placed in an airy store-room, and not suffered to touch each other; they are best aired when placed in an open movable lattice work.

Hyacinth bulbs are liable to various diseases, one of the most common is what is known as the *ring sickness*. When this occurs the diseased part must be cut out, and if the disease has not penetrated beyond the outside coat, the bulb will survive this operation, but it is now only fit for producing offsets. This disease is very prevalent in Holland, and is attributed to a fungus, the spawn of which comes from the cow dung used as manure. The hyacinth delights in a sandy soil, and saline atmosphere, and on this account it succeeds best near the sea coast, or situations adjoining the sea. In more inland parts it will, generally, be found necessary to procure an annual supply of fresh imported bulbs, in order to make good the losses. Herbert remarks, "my experience enables me to say, that the nursery man in the neighbourhood of London may produce hyacinth bulbs equal, if not superior, to those imported from Holland, though perhaps with greater loss from disease, owing to his not being able to procure the dung of

cattle fed upon hard food, and free from straw." Hyacinths may be forced by planting the roots in narrow deep pots, filled with sandy loam, in October. These are to be plunged in old bark and sand, the bulbs will soon throw down roots, and a part may in November be plunged into bottom heat, when they will blow about Christmas. A succession from the original stem, thus treated will afford a bloom till the spring.

Hyacinths form a beautiful ornament when grown in glasses. For this purpose blue or any dark coloured glass is preferable to white, because too much light is injurious to the bulb. The bulbs, for this purpose, should be put into earth in October, in which they push out their fibres more regularly, and they can be taken up as wanted, washed from earth, and placed in the glass, which should be kept in a warm room or store. Soft water should be used, and the glass is to be filled up so as to cover a quarter of an inch of the bulb. As soon as the water becomes fetid and muddy it should be renewed. When these bulbs have done flowering, they are to be removed from the glasses with all their leaves and roots, and planted in an appropriate soil. When the leaves have completely withered, the bulbs are to be taken up and preserved dry till the latter end of October, when they may be planted in beds in the usual manner.*

THE TULIP *(tulipa gesneriana)*. Natural family, *liliaceæ; hexandria, monogynia*, of Linnæus. This celebrated bulb is a native of the Levant, and is common in Syria and Persia. The Persians call it *thoulyban*, hence the French *tulipan*, and the English tulip. This plant appears to have been brought to Europe from Persia, by way of Constantinople, in 1559, and in a century afterwards to have risen into an object of considerable trade in the Netherlands. At this period, indeed, and for long afterwards, a sort of mania for this and other bulbs prevailed among the Dutch; individual bulbs were not unfrequently sold for £500 and upwards, and immense sums of money lost and won by speculations in this favourite flower. In England it was first cultivated by Garnett, who, according to Hakluyt, obtained the roots from Vienna.

The taste in England was at its height about the end of the seventeenth and beginning of the eighteenth century. It afterwards declined, and gave way to a more extended taste for various rare plants from foreign countries. The tulip, however, is still extensively cultivated in Holland, from which all Europe is supplied with bulbs. It is also still raised to a considerable extent near large towns in England. It has, however, lost in a considerable degree that fashionable patronage which it at one time acquired, and of consequence the prices of bulbs have become much more reasonable.

The natural colour of the petals of the tulip is generally of a uniform hue, either white, purple, or red. The object of culture is to diversify and mix colours to as great an extent as possible. Hence innumerable varieties have arisen.

Mason's London catalogue enumerates six varieties of early blowing tulips; four perroquets or middle blowers, twenty-two double sorts, and upwards of 600 single, the last being the only kind valued by connoisseur florists.

The beau ideal of a first rate tulip is thus minutely specified. The stem should be strong, elastic, and erect, and about thirty inches above the surface of the bed. The flower should be large, and composed of six petals. These should proceed a little horizontally at first, and then turn upwards, forming almost a perfect cup, with a round bottom, rather widest at the top. The three exterior petals should be rather larger than the three inferior ones, and broader at their base; all the petals should have perfectly entire edges, free from notch or serrature. The top of each should be broad, and well rounded; the ground colour of the flower at the bottom of the cup should be clear, white, or yellow; and the various rich coloured stripes, which are the principal ornament of a fine tulip, should be regular, bold, and distinct on the margin, and terminate in fine broken points, elegantly feathered or pencilled.

The centre of each leaf or petal should contain one or more bold blotches or stripes, intermixed with small portions of the original or breeder colour, abruptly broken into many irregular, obtuse points. Some florists are of opinion that the central stripes or blotches do not contribute to the beauty and elegance of the tulip, unless confined to a narrow stripe exactly down the centre, and that they should be perfectly free from any remains of the original or breeder colour. It is certain that such appear very beautiful and delicate, especially when they have a regular, narrow feathering at the edge; but the greatest connoisseurs in this flower unanimously agree, that it denotes superior merit when the tulip abounds with rich colouring, distributed in a distinct and regular manner throughout the flower, except in the bottom of the cup, which, it cannot be disputed, should be a clear, bright, white or yellow, free from stain or tinge, in order to constitute a perfect flower. The principal varieties are thus arranged and characterized.

A *bizarre tulip* has a yellow ground, marked with purple or scarlet, of different shades. It is called flamed when a broad irregular stripe runs up the middle of the petals, with short, abrupt, projecting points, branching out on each side; fine narrow lines, called arched and ribbed,

* London, Herbert, &c.

often extend from this broad stripe to the extremity of the leaves, the colour generally appearing strongest in the inside petals. A tulip with this broad coloured stripe, which is sometimes called beamed or splashed, is at the same time frequently feathered also.

It is called feathered when it is without this broad stripe, but yet it may have some narrow lines joined or detached, running up the centre of the leaf, sometimes branching out and curved towards the top, and sometimes without any spot or line at all; the petals are feathered more or less round the edges or margin, inside and out; the pencilling or feathering is heavy or broad in some, and light and narrow in others, sometimes with breaks or gaps, and sometimes close, and continued all round.

The *Bybloemen tulip* has a white ground, lined, marked, striped, or variegated with violet or purple, only of various shades, and whether feathered or flamed, is distinguished by the same characters and marks as the bizarre tulip.

The *Rose tulip* is variegated with rose, scarlet, crimson, or cherry colour, on a white ground; and the feathered rose is to be distinguished from the flamed by the rules already mentioned; the rose is very often both feathered and flamed.

The *self* or *plain coloured tulip* is either uniform white or yellow, admitting of no farther change.

These last are called breeders, and are procured from seed. On being cultivated on a dry, poor soil, they gradually become broken up or variegated, and thus furnish new varieties. The time that elapses before they break, varies from one to twenty years, or even more; while, in some instances, this change never takes place at all. Various plans have been suggested for promoting and expediting the breaking up of these selfs or breeders, but none hitherto tried can be depended upon. The most likely is the fecundation of one unbroken by the pollen of a variegated tulip, having previously removed the stamens of the former before their anthers have arrived at maturity. Some florists raise seedlings from their choicest flowers, in the expectation that they will break up sooner than seedlings from selfs. This is accordingly found to be the case; but, in general, the plants are weaker than those raised from the simple or natural tulip, the variegated colour being undoubtedly a symptom of disease or morbid action in the plant. Frequent change of soil and situation is also recommended as a means of expediting the variegation of tulips.*

In raising from seed, that from healthy and strong plants is to be preferred, and it is not to be gathered till the pericarp assumes a brownish colour. It is to be sown in the same manner as hyacinth seed, and the bulbs similarly treated. They will bloom by the fourth, fifth, and seventh years.

Offsets should be planted soon after they are separated from the parent bulb in beds of fresh, sandy loam, with a little rotten cow dung placed from seven to twelve inches below the surface, in a dry, airy situation, from two to four inches deep, according to the size of the roots. The beds should be elevated six or eight inches, rather convex in the middle, and should be furnished with mats and hoops, to be put on for occasional protection from heavy rains and severe frosts.

The best bulbs are those which have not lost the brown skin, are not mouldy, or soft at the root end, and are full, solid, and rather pointed at the other. Immediately before planting, the brown skin is to be carefully stripped off, so as to leave the root perfectly bare, meanwhile cautiously avoiding to bruise or wound the root, especially at the lower end where the fibres are formed, which is very tender at the season of planting. The soil of the beds should be a rich loam, of rather a sandy nature, with a mixture of cow dung manure. These beds should be prepared in October, and the planting should take place from the 1st to the 10th of November. The day selected should be dry, and the bulbs are to be planted at seven inches distance each way: from five to seven rows form a splendid bed, if it have sufficient corresponding length. Each root should be enveloped with a little clean sand, and then covered with four inches of mould for the larger middle roots, decreasing the depth of those towards the edges to three inches.

By the end of February every healthy plant will be visible above ground, and some of the earliest sorts from two to three inches high. Any distemper or canker in the foliage, either above or a few inches below ground, should be in a dry day cut out with a knife; the part will soon close up again. If the surface of the bed is too close and stiff, it should be carefully stirred up. As soon as the earliest flowers appear they should be shaded from the sun, so as to preserve their colour, and retard their blowing, as directed with regard to the hyacinths. The mattings or coverings, should also be applied during winds or heavy rains. Tulip beds require no watering from the time of planting till the taking up of the roots, even in the driest seasons; but moderate showers may be admitted both before and after their blowing is over. In early spring, rain is necessary in order to promote the vigour of the plants.

Tulips will bear to be covered or shaded from light longer than any other plant, without sustaining any injury. Thus they will bear to be covered up for three weeks with perfect safety.

About a week or ten days after the full blow

* Hogg's Culture of Florist's Flowers.

of the bed, and when the petals of many flowers begin to drop off, the awnings should be taken down and the mats replaced as before, to throw off heavy rains. As the leaves and petals fall off from a plant, the seed vessel should be immediately broken off from the stem; for if suffered to remain, it will delay the maturity of it, and weaken the root considerably. The bed may remain in this state about a fortnight longer, by which time the grass or foliage will become of a yellowish brown; and two or three inches of the top of the stem will wither, dry up, and become purplish. This denotes the critical period to take up the roots, because if done earlier they will be weak and spongy, and if deferred later, their juices will become gross. This will be apparent at the succeeding bloom by too great a redundance of colour in the petals, and the flowers being what is generally termed foul.

The early dwarf varieties are best adapted for forcing in pots and water glasses. The bulbs are to be treated in the same way as described for hyacinths; and after blowing, they are to be recovered by putting them into earth. Tulip bulbs are liable to few diseases, and are in general healthy. If attacked by the grub or wireworm, the bulb must be totally removed, and replaced by a fresh one. A fungus sometimes attacks the bulb, and in this case transplantation into a fresh soil is necessary.

The Ranunculus *(r. asiaticus)*. Natural family *ranunculaceæ; polyandria, polygynia*, of Linnæus. The wild ranunculus crow foot, or butter cups, are a well known family of weeds, of which there are many species. The garden ranunculus is esteemed as being a double flower, and as possessed of great beauty, and variety of colours of the numerous petals. It is a native of the Levant. The leaves, which are bipartite, spring from a bunch of tubers. The stem is erect, branched, and the flowers are terminal. It was introduced into Britain by Gerard, in 1596, and soon became a favourite in the flower garden. No flower is so prolific in varieties. Maddock enumerates not less than eight hundred sorts; and he states that a variety will last for twenty-five years.

The necessary qualities of a perfect double ranunculus are a strong straight stem, from eight to twelve inches in height, supporting a large, well formed blossom, at least two inches in diameter; consisting of numerous petals, the largest at the outside, and gradually diminishing in size as they approach the centre, which should be well filled up with them. The blossom should be of a hemispherical form; its component petals should be laid over each other in such a manner as neither to be too close and compact, nor too widely separated, but have rather more of a perpendicular than horizontal direction, to display their colours with better effect. The petals should be broad, and have perfectly entire, well rounded edges; their colours should be dark, clear, rich, or brilliant, either consisting of one colour throughout, or otherwise variously diversified on an ash white sulphur, or fire coloured ground, or regularly striped, spotted, or mottled in an elegant manner.

The ranunculus is propagated by seed for obtaining new varieties, and for perpetuating approved sorts by offsets, or by dividing the tubers into as many portions as there are eyes. According to Maddock, the seeds in no instance ever produce two flowers alike, or the same as the original stock. He directs it to be saved from such half double flowers as have tall strong stems, and a considerable number of large, well formed petals, and rich, good colours, the darker chiefly to be preferred, though not to the exclusion of a proportion of lighter coloured, if good. The seed should remain on the plant till it has lost its verdure, and becomes brown and dry. It may then be cut off and spread abroad upon paper, and exposed to the sun, that it may be thoroughly dried, after which it should be put into a bag, and preserved in a warm, dry place. The seed may be sown in October or January, in beds prepared with frames and glasses. It should be strewed thickly on the surface of the prepared soil, and then covered with a sprinkling of mould, not exceeding in thickness the eighth of an inch. The plants usually appear in about a month. They are regularly watered, and air is admitted day and night, except in severe frosts when they are covered with matting. In summer the roots are taken up and preserved till the following February, when they are planted with the general stock.

The offsets from the tubers of the ranunculus, unlike those from the hyacinth and tulip, will flower the same season in which they are removed. In minutely examining the crown of a tuber, several small protuberances will be found, from each of which a shoot will arise, and the root may therefore be divided by a sharp knife into as many parts as there are protuberances; but these sections will not blow till the second year.

The best soil for the ranunculus is a fresh, strong loam, with a quantity of rotten cow dung; the situation of the bed should be open, but not too much exposed to high winds, or currents of air. The bed should be about eighteen inches in depth, and raised about four inches above the walk. The dung should be put five inches below the surface, the soil above this being kept perfectly free from manure. Fresh, full tubers, with prominent buds, are to be selected; and the time of planting may be either in the end of autumn, or early in spring. If the soil and situation be very cold and wet, it will

be better to defer this operation till February; in milder situations the planting may take place in October, or beginning of November. The surface of the bed should be raked perfectly even and flat, and the roots planted in rows, at the distance of five inches from each other. A little clean sand should be placed in the hole or trench, and the roots are to be placed with their claws downwards. Earth is then applied, so as to cover the roots to the depth of one inch and a half. When deeper or shallower than this, the plant will not thrive well, as this seems their natural position. The roots remain several days in the ground after planting before they begin to vegetate, and during this time they swell very much by imbibing the moisture of the soil, and are in this state very susceptible of injury from frost, which is to be guarded against by covering the surface of the bed with straw, whenever indications of a diminished temperature are felt, and which may be removed when the frost is gone.

Early in spring when the plants show themselves distinctly, the surface of the earth between each row should be trodden or beaten down, so as to make it firm and compact; and if the soil is compressed with the fingers quite close to the plants, it will keep out cold drying winds, and prove beneficial. This should be done in a fine dry day soon after rain, whilst the ground is still moist; and when completed, a little long straw should be placed between each row, to preserve the surface of the soil cool and moist till the foliage of the plants is sufficiently grown and expanded, to afford it shade without further assistance. Natural showers in April and May are essential to the healthy vigour of the plants; but if these fail, soft water must be supplied, by pouring it from a pan between the rows, avoiding as much as may be, wetting the plants, as the subsequent evaporation is apt to chill and injure the foliage. If the sun is too strong, the beds require to be shaded by mats or awnings, properly adjusted. After the bloom is over, watering is no longer necessary; but shading from the hot noonday sun, is still requisite.

By the end of June the plants assume a dry, brown appearance; vegetation has then ceased, and it is the proper time to take up the roots; for, if left till rainy weather comes on, they will begin to spring again. When the roots are taken up their stems should be cut close off, and they should be placed in a shady, airy apartment, so as they may dry gradually, and in which place they may remain till the season of planting. Roots can thus be kept in a dry place for three, and even five years, without impairing their power of vegetating, although the vigour and beauty of the plant is diminished.

The wild species of ranunculus, common in this country, especially the *bulbosus*, *sceleratus*, *acris*, and *repens*, are shewy looking meadow flowers, and are characterised by the extreme acrimony of their juices. Formerly they were used in medicine, and sometimes employed for causing a blister externally. Beggars are said also to employ them for the purpose of creating artificial sores and ulcers. The fresh roots are acrid and poisonous; but when old and dry, become so innocuous as to be eaten. Hogs are fond of them, and frequently dig them up. Sheep and goats are also said to browse on the plant, while cows avoid it.

There is a vulgar notion that these plants give the rich yellow colour to butter, and hence the name of butter cups. This, however, is a mistake, as the richness of the pasture, and the luxuriance of the grasses, are the sole cause of the superiority of the butter produced. The *r. acris*, as well as *bulbosus*, is sometimes found double. In this state it forms a common flower in gardens, under the name of bachelor's buttons.

The water ranunculus, *r. aquaticus*, has large flowers, which are very conspicuous on the margins of ponds and ditches. According to Dr Pultney, this species is not poisonous; on the contrary, cattle eat it, and thrive on it. In the neighbourhood of Ringwood, on the borders of the Avon, some of the cottagers support their cows, and even horses, almost wholly by this plant.

A man collects a quantity every morning, and brings it in a boat to the edge of the water, from which the cows eat it with great avidity, insomuch that they stint them, and allow only about twenty five or thirty pounds to each cow daily. One man kept five cows and one horse so much on this plant, with the little which the heath afforded, that they had not consumed more than half a ton of hay throughout the whole year, none being used except when the river is frozen over. Hogs also are fed with this plant, and improve so well on it, that it is not necessary to give them any other sustenance till they are put up to fatten. This property of water crowfoot is the more remarkable, as all the other species have been esteemed acrimonious, and some of them even deadly poisons.

The Anemone. Natural family *ranunculaceæ; polyandria, polygynia*, of Linnæus. The anemones are nearly allied to the ranunculus. There are a number of species growing wild in this country; many are common to the south and north of Europe and America, while others are found in China and Japan. There are two species cultivated as garden flowers. The poppy anemone *(a. coronaria)*, a native of the Levant, and introduced into this country in 1596; and the star or broad-leaved anemone *(a. hortensis)*, a native of Italy, and brought to Britain from Holland about the same time as the other. Both have been cultivated with the same assid-

uity as the tulip. There are a great many varieties, both single and double. Mason enumerates seventy-five, the single and semi-double flowers being as much prized as the double.

A fine double anemone should have a strong, elastic, and erect stem, not less than nine inches high. The flower should be at least two inches and a half in diameter, consisting of an exterior row of large, substantial, well rounded petals, or guard leaves, at first horizontally extended, and then turning a little upwards, so as to form a broad shallow cup, the interior part of which should contain a great number of long small petals, overlying each other, and rather turning from the centre outwards. There are a great number of small, slender, and imperfect stamens, intermixed with the petals; but they are short, and not easily discernible. The colour should be clear and distinct when diversified in the same flower; or brilliant and striking, if it consists only of one colour, as blue, crimson, or scarlet, in which case the bottom of the broad exterior petals is generally white. But the beauty and contrast is considerably increased, when both the exterior and interior petals are regularly marked with alternate blue and white, or pink and white stripes, which in the broad petals should not extend quite to the margin.

These flowers are propagated by seed for obtaining new varieties, and by dividing the root for continuing approved sorts. The seed should be collected from the best flowers, and collected gradually as it ripens, else it is apt to be blown away with the wind. It is to be sown and treated exactly in the same way as described for the ranunculus, and the seedlings, like them, will blow strong the second year. There will be found but few double flowers among the seedlings; but the greater number of broad petals the flower of the seed bearer possesses, the greater is the probability of procuring large double flowers from its seed.

When the root of an approved sort is carefully divided, every division will blow the first year.

The first grown selected roots are to be planted in the same way as the ranunculus; and as the anemone is a hardier plant, it may be put into the ground in autumn. When they come up they are to be watered and protected from the weather. After the bloom is over, the plants are to be shielded from moisture, so as that the roots, which are very succulent, may dry, and not spring afresh. They are at the proper time to be taken up and sorted; and as they are very brittle, care must be taken in handling them.

The soil best suited for the anemone is a fresh loam, rather sandy. The roots should be covered to the depth of three inches.

The roots of the anemone are solid, flattened masses, not unlike ginger. Those that have been two or three years in the ground, attain a great size. They are generally sold by weight as one root, and are divided afterwards at the period of planting.

Besides the two species just described, the *a. pulsatilla*, or pasque flower, is also common in flower borders.

The Crocus *(crocus vernus)*. Natural family *irideæ; triandria, monogynia*, of Linnæus. This plant was so named by Theophrastus. In Ovid's metamorphoses, a youth so named is fabled to have been changed into the flower. There are several species of this genus; and the brilliancy of their flowers, but, above all, the early period at which they blow, renders them favourites in the flower garden.

When these plants are in flower, the germen or seed vessel is still under ground, almost close to the bulb; and it is not till some weeks after the decay of the flower, that it emerges on a white peduncle, and ripens its seeds above ground. This peculiarity is very conspicuous in the naked autumnal crocus, *(c. nudiflorus)*, which flowers without leaves in autumn, and throws up its germen the following spring, in a similar way as already described with the meadow saffron. It is supposed that the native country of the crocus is Asia, though several species are naturalized in Europe; and three are found wild in England, the spring crocus, the saffron, and the autumnal naked crocus.

There are from twelve to twenty leading varieties of the garden crocus, all single. The colours are yellow, blue, purple, white, and variegated.

According to Haworth, the seeds should be sown immediately after they are gathered, in light earth, in a shady but open situation. Sift over them half an inch of earth the first autumn, and take them up the second year, and immediately replant them. Add another half inch of earth the third autumn, and the following spring most of the plants will show flowers in the midst of their fourth crop of leaves. Afterwards they may be treated like old bulbs, and planted in the open borders or shrubbery, on patches or rows. The bulbs of the crocus being renewed every year, and the new bulb formed on the top of the old one, it follows, that at whatever depth they have been planted, they will in a short time rise to the surface; unlike the tulip, and the bulbous iris, whose new bulbs being formed under the old ones, soon sink the plants, unless growing on a hard subsoil. Crocus bulbs should be taken up every third year after the leaves decay, dried in the shade, parted, and replanted three inches deep, and not later than Michaelmas. The longer they are kept out of the ground after this period, they become weaker, and are later of flowering. In this way, and by preserving them in an ice house, they may be

retarded, so as to flower at midsummer or later; and they may be also forced by heat, or put into water glasses, or in fancy pots, with numerous holes, as is commonly seen in the seed shops.*

The saffron crocus *(c. vernus)*, was at one time extensively cultivated in Britain, both for a dye and as a medicine. A cheaper foreign supply has now, however, superseded this culture. As a medicine, though at one time much used and esteemed, it is now entirely disregarded.

Narcissus. Natural family *amarillideæ; hexandria, monogynia*, of Linnæus. This family of bulbous-rooted plants, contains upwards of fifty species. Most of them are natives of the south of Europe, and the Levant. The common daffodil, and one or two more species, grow wild in woods in Britain.

The Greeks called them narcissus on account of their odour, causing frequently a stupor and fainting in those who inhaled it. For this reason too, these flowers were consecrated to the Furies, who were fabled to have been in the practice of stupifying those victims whom they wished to punish, by ordering them to smell them.

The best roots are obtained from Holland; and from Naples comes the Italian narcissus, which grows in abundance in the neighbourhood of that city.

This genus has been divided by florists into daffodils, white narcissus, jonquils, and polyanthus narcissus.

Daffodil (pseudo narcissus). The varieties of this are the common double, the double with white petals and a yellow cup; the two-flowered and two-coloured daffodil, the great yellow Spanish, and others.

The *White Narcissus (n. poeticus)*, of which there are the early flowered, the musk, the yellowish, and large flowered.

The *Jonquil (jonquilla).* The common, double flowered, sweet scented.

The *Polyanthus Narcissus.* The common, sulphur coloured, single and double, with numerous other varieties.

The tests of fine plants of narcissus are: strong erect stems, regularity of form and disposition in the petals and nectaries, distinctness and clearness of colour; and in the many flowered sorts, the peduncles all of the same length, and coming into flower at once.

They are propagated by seed for obtaining new varieties, but most commonly by offsets from the bulbs. As these offsets seldom flower the first year, they should be planted in a bed by themselves, composed of light, loamy soil; and they should be put into the ground not later than the end of August, or beginning of September.

* Encyclopedia of Gardening.

The seeds collected from the choicest plants should be sown in flat pans, filled with fresh, light, sandy earth, about the beginning of August, or soon after the ripening of the seed. These pans should be in a shaded place, and only exposed to the morning sun till October; after that they are to be exposed to the full sun, but protected from heavy rains and frosts, until April. In June the leaves will have decayed, when some fresh earth is to be sifted over the surface of the pans.

During the second winter the same treatment is to be pursued, and in the following summer, the roots are to be taken up and planted at three inches asunder, in raised, convex beds; in other two years they are again to be moved and replanted at double the distance in mould, with a little cow dung. In the fifth year after sowing, most of the bulbs will come into flower, and the remainder next year. The flowers frequently improve in beauty in the second or third year, so that no bulbs should be finally discarded until they have had this trial. Those bulbs with a round base, and full sound tops, are the best. The best soil is a fresh, light loam, with a little cow dung, and dug to the depth of three feet; and an eastern aspect is to be preferred. Stirring the soil occasionally, and weeding, and watering, are all the requisites in their culture. In winter the beds require the protection of tan or litter. The bulbs should not be taken up oftener than every third year; for if they are allowed to remain longer, the plant is weakened by the numerous offsets. These bulbs may be forced during winter in pots, or in water glasses, where they become beautiful and odoriferous ornaments for apartments.

The Iris. Natural family *irideæ; triandria, monogynia*, of Linnæus. This family of plants, from their varied colours, were called by the ancients after the name of the rainbow. The species are distributed over Europe, Asia, and America. Some are used in medicine, and others cultivated as ornamental flowers. Of the latter, the most admired species are:

The *Persian Iris (i. Persica).* This is a very long, bulbous rooted plant, with delicate blue and violet coloured flowers, possessing a powerful and pleasing odour. As the name implies, it is a native of Persia, and was first cultivated in this country by Parkinson, in 1629. The bulbs are generally imported from Holland; and as they do not thrive well, or ripen their seeds in the open air in this country, they are forced in pots, or in water glasses.

The *Snake's Head (i. tuberosa)*, has long, narrow, four-cornered leaves, and a dark purple flower, which appears in April. It is a native of the Levant, and also grows wild in England, and Ireland. It is cultivated in warm borders, in a light loam.

The *Chalcedonia (i. susliana)*, has finely striated leaves, a scape a span high, and the largest and most magnificent corolla of all the species. Its petals are of a delicate texture, almost as broad as a hand, purple or black, striped with white. It flowers in the beginning of June, is a native of the Levant, and was cultivated by Gerarde in 1596. It thrives best in a loamy soil, and sunny, warm situation, protected in winter from rain and frost.

Bulbous rooted, or *Spanish (i. xiphium)*, has channelled leaves, convoluted in their whole length, and awl-shaped at the tip. The flowers of the wild plant are blue, with emarginate petals, and appear in June; but cultivation has produced a great number of varieties, with yellow, white, violet, and variegated flowers. It is a native of the south of Europe, and was cultivated in Britain by Gerarde, in 1596.

The *Great bulbous rooted*, or *English (i. xiphioides)*, is much larger in every respect than the former. The flower stalk is nearly twice the height, and the flowers more than double the size. It runs into numerous varieties.

Both these species are much cultivated and esteemed by florists. They are raised in a light sandy loam, with an eastern exposure. They are multiplied abundantly by offsets, and may also be readily raised from seed. For this purpose the seed may be sown in drills early in autumn. With no other care than frequent weeding, they may remain in the seed bed for three years; for they are much more hardy than most kinds of seedling bulbs, and therefore will not even require protection from the frosts. In the autumn of the third year, it will be necessary to transplant them into beds at one foot distance, row from row, and the bulbs six inches apart; and in two years from their removal, most of the strongest will show blossom, and nearly all in the year following, or the sixth from the seed. The flowering bulbs should be taken up every third year, in August, and, if possible, they should be replanted in September, as those kept out of the ground till Christmas rarely blossom in the succeeding summer. These roots are seldom or never forced.

Fritillary *(fritillaria)*. Natural family *lileæ; hexandria, monogynia*, of Linnæus. These are also showy flowers, natives of Asia and of Europe. Three species are cultivated as garden flowers.

The *Crown Imperial (f. imperialis)*. This has a scaly bulb, from which spring strong stems from two to four feet in height, furnished with numerous broad, shining, green leaves; and crowned with a whorl of showy, pendulous flowers, yellow, red, striped, and variously coloured, which make their appearance in March and April. "The singular nectary of this flower," says Professor Martin, "cannot but engage the attention of the curious observer; it is a white, glandular cavity at the base of each petal, and has a drop of limpid nectareous juice standing in it, where the flower is in vigour. Another of the wonders of nature may be observed in the peduncles, which bend down when the plant is in flower, but become upright as the seed ripens." There are several varieties of this flower, indicated by colour and the disposition of the stripes.

The *Persian Fritillary (f. Persica)*. This species has a large round root, the size of an orange; the stem is three feet high, and the flowers appear in a loose spike at the top, forming a pyramid. They are of a dark purple colour, and appear in May; but seldom produce seeds in this country, its native climate being Persia. There is another variety with a shorter stem, and smaller leaves and flowers.

The *Common Fritillary*, or *Chequered Lily (f. meleagris)*. This species has a solid tuber, about the size of a nut; a stem from twelve to eighteen inches in height, with linear leaves, and one or more pendulous flowers on the top of the stem. It is a native of Britain, and flowers in April and May, or in mild seasons, as early as March. There are about twenty varieties, with white, red, purple, black, striped, and double flowers, besides an umbellate variety, a mule between this species and the crown imperial.

The common method of propagating the fritillaries is by offsets; but they may also be raised from seed, which ripens readily, and is to be treated in a similar manner as that of the tulip.

The seedlings of the crown imperial flower in the fifth or sixth year, and those of the two other species in the third or fourth year. The bulbs should be planted in a light soil, not too wet, or with much dung. It should be dug deep, the bulbs to be put six inches below the surface, and from eighteen inches to two feet distant every way. They, however, look to most advantage not in beds, but in a mingled flower border.

The roots require to be taken up only every third year, and should be again quickly planted.

The Lily *(lilium)*. Natural family *liliaceæ; hexandria, monogynia*, of Linnæus. This genus contains at least twenty species of beautiful flowers. The name is from the Celtic word *li*, signifying whiteness, the lily having been long considered an emblem of whiteness and purity. A few of the most interesting species are as follows:

The *White Lily (l. candidum)*. This has a large scaly bulb, a leafy stem, from three to four feet in height, terminating in large, pure, white flowers, on peduncles. It is a native of the Levant, and was common in English gardens in Gerarde's time. There are above eight varieties of this species.

The *Orange Lily (l. bulbiferum)*. This showy flower has a scaly bulb, a leafy stem, two and a half feet high, terminating in large orange coloured flowers. Sometimes the stem produces small green bulbs in the axillæ of the leaves. Of this species there are eight or ten varieties, the *umbellatum* being the most showy. It is readily propagated by offsets.

The *Turk's Cap (l. martagon)*, has a large scaly bulb, a stalk furnished with narrow leaves, about three feet high, with terminating peduncles of fine carmine flowers, which blow in July. There are several varieties, the most remarkable being, the scarlet Turk's cap, and the yellow perianthed Turk's cap.

The *Japan Lily (l. Japonicum)*, is a noble flower, with a stem five feet high, and flowers seven inches broad, of a pure white, with a streak of blue.

The *Tiger Lily (l. tigrinum)*, with the upper leaves cordate, oval, and petals spotted.

All these are most commonly propagated by offset bulbs; but new varieties may also be raised from seed. The seedling bulbs flowering in the fifth or sixth years.

The common sorts will thrive in almost any situation, even under the shade of trees. The more tender sorts require protection in the green-house, or in a garden frame.

The tiger lily is most vigorous when it is planted in heath mould. None of this species, nor indeed any bulbous plant, should be moved after the leaves are pushed out, otherwise they will be so weakened, as to produce a feeble flower.

Amarillis. Natural family *amaryllideæ; hexandria, monogynia*, of Linnæus. This splendid family of plants derive their name from the Greek word, signifying resplendent. It is also the name of a nymph, celebrated by the ancient poets. Most of these species are natives of the Cape of Good Hope, China, or South America, and are therefore green-house plants in this country.

The green-house species of this family thrive best in a light, loamy soil, and should have but little water given them after they have done flowering, so that the bulbs may harden, to produce more flowers the following season. New varieties are procured by sowing the seeds; but the most usual mode of propagation in this country is by offsets. A shell taken from the bulb with a leaf on it, and planted in a pot of mould, will produce a bulb, as, indeed, will almost any bulbous-rooted plant.

The stove amaryllises grow best in light loam and rich soil; and the larger kinds, if placed in capacious pots, throw up magnificent flowers. The great art in cultivating these and all other bulbs, according to Knight, is to procure vigorous leaves; on these depend the quantity of nutritive matter prepared and deposited in the bulb, which is an essential requisite for its flowering next season: for bulbous roots increase in size, and proceed in acquiring powers to produce blossoms only during the periods in which they have leaves, and in which such leaves are exposed to light; and these organs always operate most efficiently when they are young, and have just attained their full growth. Thus the bulb of the Guernsey lily, as it is usually cultivated in this country, rarely produces leaves till September, or the beginning of October, at which period the quantity of light afforded by our climate, is probably quite insufficient for a plant said to be a native of Japan; and before the return of spring its leaves are necessarily grown old, and nearly inefficient, even though protected well from the winter frosts. It is not extraordinary, then, that a bulb of this species which has once expended its energies in producing flowers, should but very slowly recover the power of again blossoming.

On these premises Mr Knight accordingly inferred, that nothing more was necessary to make this lily blossom as freely as it does in Guernsey, than such a slight degree of artificial heat applied early in the summer, as would prove sufficient to make the bulbs vegetate a few weeks earlier than usual in the autumn. Early in the summer of 1816, a bulb which had blossomed in the preceding autumn, was subjected to such a degree of artificial heat as occasioned it to vegetate six weeks earlier than it would otherwise have done. It did not of course produce any flowers; but in the following season it blossomed early, and strongly, and afforded two offsets. These were put in the spring of 1818, into pots containing about one-eighth of a square foot of light and rich mould, and were fed with manured water; and their period of vegetation was again accelerated by artificial heat. Their leaves consequently grew yellow from maturity, early in the next spring, when the pots were placed in rather a shady situation, and near a south wall, to afford them an opportunity of observing to what extent in such a situation the early production of the leaves in the preceding season had changed the habit of the plant. I entertained no doubt but that both the bulbs would afford blossoms; but I was much gratified by the appearance of the blossoms in the first week in July. From the success of the preceding experiment, adds Mr Knight, I conclude, that if the offsets, and probably the bulbs of this plant which have produced flowers, be placed in a moderate hot bed in the end of May, to occasion the early production of their leaves, blossoms would be constantly afforded in the following season; but it will be expedient to habituate the leaves thus produced gradually to the open air, as soon as they are nearly fully

grown, and to protect them from frost till the approach of spring. Various hybrids of great beauty are readily produced from the species of this family.

The Hæmanthus, or Blood Flower. This is a genus belonging to the same natural family as the above, and so called from the brilliant red colours of the flower. These are chiefly green-house plants, and thrive best in a sandy loam, with a little heat.

Hæmanthus multiflorus is a tender stove bulb, which requires a high temperature. They are to be watered sparingly at first, but require a frequent supply afterwards, taking care not to pour the water over the leaves, as it is apt to get into the heart of the plant and rot it.

The Tuberose *(polyanthes tuberosa)*. Natural family *hemerocallideæ; hexandria, monogynia*, of Linnæus. This flower is a native of India. The root is tuberous, the stem upright, the leaves linear and lanceolate, the flowers numerous, and very fragrant. It was introduced into Europe about the year 1524, and is much esteemed as a green-house bulb; in warmer situations, it will also blow in the open air. The tubers are annually imported from Italy, and the warmer parts of North America, and sometimes from Guernsey, although, by proper management, it is believed they could be easily raised in this country.

The bulbs are planted in pots of sandy loam, in March or April, and brought forward in a hot-bed, or hot-house, till the flower buds begin to appear. The pots are then removed to the green-house, or open air, or to halls, or churches, as practised in Italy, where the cooler temperature procures a prolonged bloom. Or they may be planted in a warm, open border, in the following manner.

A pit is to be dug two or three feet deep, and filled with fresh stable dung about the middle of April; over this is spread a layer of light sandy earth, and the tubers planted at the distance of five inches apart, the upper part of the tuber being just covered with the earth. Little or no water is to be given at first, but the bed is to be protected by a covering from frost and rain; when the leaves are about an inch long, a little fresh compost is to be added to the surface; and in June and July, when the leaves are in full vigour, copious watering is necessary, especially after warm sunny days. In autumn and winter, the bed is again protected from rains and frost. In February the roots are to be taken up, and packed in the sand till the period of planting in April. In short, according to Salisbury, the object is to keep the roots growing as vigorously as possible from May till October; but in the winter months, to keep them in a state of complete rest and drought. By this process bulbs may be produced equal to those imported from abroad.

The Pæony. Natural family *ranunculaceæ; polyandria, digynia*, of Linnæus. The peony was so called after the Greek physician Pæon, who is said to have employed it in medicine, and used it to cure Pluto of a wound inflicted by Hercules. It is esteemed by the moderns as a splendid flowering plant.

There are two principal kinds, the common *(p. officinalis)*, which is an herbaceous flower, a native of Switzerland and other parts of Europe, and also of Asia; and the *moutan*, or Chinese tree, which is shrubby, a native of China and Japan.

Besides these there are several other species, and a number of varieties, especially of the herbaceous kinds. The herbaceous peonies are propagated by seed, selected from the single and semi-double sorts, in order to procure new varieties; and by dividing the roots for ordinary purposes. The seeds are to be sown in light, fresh earth immediately after they are ripe, which is in September, and covered up with half an inch of earth. They will come up in the following spring; and may remain in the seed bed two years before they are transplanted, sifting a little fresh earth over them when the leaves decay at the end of the growing season. After two years' growth in the seed bed, they are to be transplanted in September into other well prepared beds of light fresh earth, and placed six inches apart, and three inches deep. Here they are to remain till they flower, which is generally the fourth or fifth summer after sowing. Full grown roots are readily propagated by parting, taking care to preserve a bud on the crown of each offset. The plants are very hardy, growing in almost any soil, and even under the shade of trees, where, it is said, they continue longest in beauty. Being large and showy flowers, they form an appropriate ornament to the parterre or shrubbery.

The shrubby pæonies are usually propagated by divisions, or layers; but they may be also grafted on the roots of the herbaceous sorts, or struck from cuttings. The grafting is done any time from the beginning of September to the middle of March. Select some good tubers of the common or any other sort, and take off cuttings of any of the tree kinds to be selected. Then slit the tuber from the crown downwards about two inches from the scions, like a wedge, insert it into the slit of the tuber, and fit the barks on one side as accurately as possible. Then bind them well together with good bast, over which put one turn of brass wire, to prevent the parts from separating; after the bast is decayed, put them into pots deep enough to allow the mould to cover the top of the tuber; set them into a cold frame or pit, keep them close, rather dry, and defended from the sun for the first month, and from frost during winter.

When they have perfected one season's growth, plant them out, or treat them like established plants.*

Although the shrubby pæonies will stand this climate in warm sheltered situations, without any winter covering, yet, in general, the protection of a frame is required, especially as the leaves which come out early in spring, are apt to be nipt by the frosts. The best sort is a rich sandy loam. As the growth of these plants is very slow, they require very little pruning, and, indeed, not much care in any respect.

The shrubby pæonies may also be propagated by cuttings. For this purpose, in February select a stem from any of the species, and at the distance of half an inch from the centre of each bud, both above and below it, cut out entirely round the stem a small ring of the bark, rather more than the sixteenth of an inch wide, as is done in ringing fruit trees. Thus every bud will occupy an inch of the stem, where the direct continuation of its bark is obstructed both above and below, by the rings which have been cut out of it. The stems so prepared are then to be laid horizontally about three inches beneath the soil, leaving only the leading bud at the end of each branch above the surface. In six months every bud will have made a vigorous shoot, and, in general, will have two radical fibres at its base. In August, remove the soil from above the layers, and having raised the newly made roots, carefully separate each young shoot from the main layer, by passing a small knife from one ring to the other, cutting out about one-third part of the old stem. The young plants should then be immediately put into pots, there to remain till they are required for planting out in their final situations. After thus gathering the first crop of young plants, the old layers should be again covered with good soil, and left as before; and in the following summer a second and greater crop of plants will be produced, than in the first season; and what is more remarkable, they will issue from various parts of the stem, where no trace of a bud was previously indicated.

The Dahlia *(Georginia)*. Natural family *compositæ; syngenesia, superflua*, of Linnæus. This flower was originally named *dahlia*, after Dhal, a Swedish botanist; but as it was afterwards ascertained that another plant had received the same name, it is now changed to Georginia. This genus, of which there are two species, with several varieties, is originally a native of the sandy meadows of Mexico, in South America, and was sent to Spain in 1789, and thence to England, in the same year. These plants, however, were lost, and seeds were again introduced by Lady Holland, in 1804; and from these, and other plants imported after the peace of 1815, the present British stock has originated. It is a hardy plant, enduring our climate well, and though the leaves are coarse and large, resembling those of the dwarf elder, the great beauty of the flowers, and the circumstance of their coming into perfection in the end of autumn, when most other garden flowers have faded, have tended to raise the dahlias into estimation as a fashionable ornament of the garden.

The treatment of this plant is very similar to that of the potato; it grows freely in any soil; but the poorer the ground is, the smaller the size of the plant, and the earlier and more abundant the flowers.

There are two species of Georgiana, the *fertile rayed (g. variabilis)*, with the rachis of the leaves winged, leaflets ovate, acuminate, serrated, shining, and smooth beneath, outer involucrum inflexed. The *barren rayed (g. coccinea)*, with the rachis of the leaves naked, leaflets ovate, acuminate, serrated, roughish beneath, and the outer involucrum spreading.

The leading varieties of the fertile rayed are the purple, rose, pale, white, sulphur, yellow, tawny, copper, brick red, dark red, pomegranate coloured, dark purple, very dark and lilac flowered, single, semi-double and double, with innumerable sub-varieties.

Of the barren rayed species there are the scarlet, bright scarlet, orange saffron, and yellow flowered, single, semi-double and double, with several sub-varieties.

Besides these there are the dwarf, anemone-flowered, ranunculus-flowered, and globe-flowered.

A fine dahlia should have the flowers fully double, always filling the centre; the florets should be entire, or nearly so, pointed or rounded, reflexed, and so forming a globular kind, regular in their disposition, each series overlapping the other backwards; they may be either plain or quilled, but never distorted. If instead of being reflexed, the florets are recurved, the flower will be equally symmetrical. The peduncles ought to be sufficiently strong to keep the blossoms erect, and consequently well exposed to view, and long enough to show the flowers free of the leaves. If they are a little pendulous in the latter growing sorts, they will have a more elegant appearance. The plant ought to flower early and abundantly, and retain its characters till the end of the season. Bright and deep velvety colours are those most admired.

Georginias are propagated by dividing the roots by grafting, and from seed.

Cuttings are to be taken from the root shoots in spring, or from the tops of the young shoots early in summer. In the latter case, cut the lower end smoothly off, in the middle of a joint retaining the leaves on the top, except such as would be buried with the stem in the earth. They

* Loud. Gard. Mag. vol. 3.

should be planted in sandy earth with heat below, and covered with a hand glass, and they will strike and produce flowers and tubers before autumn.

Grafting is a mode of propagating rare herbaceous vegetables, which has been long practised on the continent. The cutting, intended for the graft of the Georginia, should be strong and short-jointed, having on it two or more joints or buds; it must be also procured as soon in the season as possible. Select also a good tuber of a single sort, taking care that it has no eyes. Cut off a slice from the upper part of the root with a sharp edged knife, and make at the bottom of the cut a ledge whereon to rest the graft. This is recommended because the graft cannot be *tongued* as in a wood shoot, and the ledge is useful in keeping the cutting fixed in its place whilst it is being tied. Next cut the scion sloping to fit, and cut it so that a joint may be at the bottom of it to rest on the ledge of the cut tuber. Tie the graft, and put a piece of soft clay around it, then put the root in fine mould, burying the graft half way in the mould, and place the pot in a cucumber frame. In about three weeks the root should be shifted into a larger pot if yet too early to plant it out into the open border. In raising from seed, this is to be collected in September from the dwarf plants, and from semi-double flowers when double varieties are desired. Perhaps seeds obtained from those particular florets of the disc which have altered their form, may have a greater tendency than others to produce plants with double flowers.* Sow in March or earlier, in a heat of about 60°, and the young plants may be pricked out in pots, and kept in a moderate temperature till the end of April. In the end of this month the whole may be planted out and protected during the night with a covering. Seedlings thus treated will blow in July, and continue in perfection until autumn, but the first frost takes the same effect on these flowers as on the potato or kidney bean. Artificial fecundation of the flowers may be practised in this manner. The flowers intended for this process should be covered two or three days previous to their expansion, in order to prevent their being fecundated by other flowers through the agency of bees or the wind. When the flower is sufficiently expanded, a camel hair pencil is saturated with the pollen of the flower, whose colour or form is desired, and with this each separate floret of the parent flower is touched, the protecting covering being continued for eight days after this operation. This fecundation requires to be repeated for two or three days, according to the weather, as the florets do not all expand at once.

In general, however, this process is not deemed necessary, as a single flower will produce all the varieties required if left to nature.

A rich loam is the best soil for those plants, and a clear open situation, free from the shade of trees or walls. Like the potato they exhaust the soil considerably, and do not thrive well when repeatedly planted on the same spot. After the flower season is over, the roots may be preserved through the winter by covering them over with a sufficient depth of old tan bark, or what is better, by taking them up and preserving them in boxes of sand.

* Sabine.

CHAP. LIII.

THE PRIMROSE, CARNATION, PANSY, &c.

The last chapter contained the account of bulbous and tuberous-rooted garden flowers of most general cultivation. In this we shall enumerate the principal ramose and fibrous-rooted plants of the flower garden.

The Primrose, *(primula)*. Natural family *primulaceæ; pentandria, monogynia*, of Linnæus. The primrose family is eminently distinguished among flowers as being one of the earliest harbingers of the spring. They are no less conspicuous for the simplicity and beauty of their flowers, and the delightful odour which they impart. Many of the species grow wild in Britain, forming the most pleasing ornaments of our woods and valleys; others are natives of the warmer parts of Europe and Asia.

The Polyanthus *(primula vulgaris)*. This species is a native of most parts of Europe, growing in woods and copses in a moist clayey soil. The leaves are obovate, oblong, toothed, rugose, and villous beneath. The umbel is radical, and flower stalks of the length of the leaves. The flowers are of a sulphur yellow colour generally and single, occasionally they are of a white or purple colour, and double. In its wild state the common primrose produces its flowers on numerous peduncles, but by cultivation it throws up a scape bearing an umbel of numerous flowers, brown, purple, red, and yellow. Linnæus, however, found the scape present in some wild sorts, but so short as to lie concealed among the leaves. Some botanists reckon the primrose, cowslip, and oxlip, all as one species. The polyanthus, at all events, is a very permanent variety, which does not readily return to the original type.

The varieties of the common primrose are numerous, and are generally divided into two classes. The first contains those whose flowers are on separate pedicles, rising from the root upon a common stem, so short as not to be seen without separating the leaves of the plant, and

are called *primroses*. The second includes those whose flowers are in umbels, on a scape or flower-stalk rising from three to six inches, or more, and are called *polyanthuses*. There are about a dozen beautiful varieties of the first in cultivation, and an immense number of the second.

The tests of a fine polyanthus are, a strong, erect, and elastic stem, and peduncles or flower-stalks. The tuber of the corolla above the calyx should be short, well filled with the anthers or summits of the stamens, and should terminate fluted, rather above the eye, or middle circle. This should be round, of a bright clear yellow, and distinct from the ground colour. The ground colour is most admired when shaded with a light and dark rich crimson, resembling velvet, with one mark or stripe in the centre of each division of the limb, bold and distinct from the edging down to the eye, where it should terminate in a fine point. The pips should be large, quite flat and round, as much as is consistent with their peculiar figure, which is circular, with the exception of those small indentures between each division of the limb, marking it out into five or six heart-like segments. The edging should resemble a bright gold lace, bold, clear, distinct, and so nearly of the same colour as the eye and stripes as scarcely to be distinguished.

The polyanthus is propagated by dividing the roots, which are perennial, or by slips; and for procuring new varieties, by sowing the seed of approved sorts. For this latter purpose the seed should be gathered about the last week of June, and in ten days afterwards it is to be sown in boxes placed in the open air, with a northern exposure. In July the plants are to be put out into open beds, taking care not to disturb the earth about the young roots when moving them. They are to be shaded from the sun, and watered for some time, till they recover their vigour. Some of these plants will show flowers the same autumn, and many in the following spring. They require to be transplanted every two years.

The best soil is a light loam, with a considerable proportion of sand, a small quantity of rotten dung, and a little leaf mould, or peat earth.

These plants are very hardy, and seldom die even in the most ungenial seasons. During the heat of summer they are, however, liable to be destroyed by snails and slugs, and by a small red spider.

The Cowslip *(p. veris)*, differs from the primrose by its shorter leaves, by the flowers hanging in an umbel or bunch, with a leafy involucrum, instead of each flower rising on a separate stalk, as in the primrose; and by the odour smelling stronger of anise. It is indigenous to most parts of Great Britain, and grows in moist pastures, and open situations, flowering in May. Both double and single varieties are cultivated in gardens, though not so frequently as the polyanthus. The most noted variety is the double cowslip, which has its corolla so multiplied as to form a full flower, like that of a double rose.*

The Oxlip *(p. elatior)*. This is distinguished from the primrose by its many flowered scape, and from the cowslip by the flat border of the corolla. It is also a native of this country, and is found in woods, thickets, and sometimes in open pastures; but it is not nearly so common as the other two species; indeed, Sir J. E. Smith is of opinion that this flower is a hybrid production from a primrose, impregnated by a cowslip. Its habit, the contraction towards the middle of the leaf, and the umbellate flower-stalk, indicating the father; whilst in the form, colour, and scent of the corolla, it most resembles the mother. If this should be the case, it would be a singular instance of the very rare connection of species in a state of nature.

The Auricula *(p. auricula)*. This beautiful species is a native of the Swiss mountains, as also of Austria, Syria, and the Caucasus. It was introduced into England towards the close of the sixteenth century, and cultivated by Gerarde under the name of bear's ear, or mountain cowslip. The leaves are obovate, entire, or serrated and fleshy, varying, however, in form, in the numerous varieties. The flowers are borne on an erect umbel, and central scape, with involucrum. The original colours of the corolla are yellow, purple, and variegated, with a mealy covering. About a century ago the taste for this flower in England was at its height; and from our gardeners the Dutch were supplied with plants till the period of the French revolution, when we again began to receive our supply from Holland. So great was the perfection to which the culture of this plant was brought, that Henry Stove, a gardener near Colchester, had some plants with not less than 133 blossoms on one stem.

Justice was a famous grower of this and other flowers; and Maddock is one of the best modern cultivators.

The best collections of auriculas are now to be found among the commercial gardeners near London, and the operative manufacturers and artizans near Manchester, Paisley, and other large towns, who devote their leisure hours to the delightful amusement of raising fine varieties of this and other flowers.

The varieties of this flower are endless. Hogg enumerates 200, and Maddock nearly 500, with names. These consist of plain, one coloured flowers, or selfs—of double flowers, and painted,

* Gardener's Mag. vol. 7.

or variegated. The latter only are esteemed by florists.

A fine variegated auricula has a strong, erect, and elastic stem, of sufficient height to carry the flowers above the leaves. The flower stalk must also be strong and elastic, and of a proportional length to the size and quantity of the pips, which should not be less than seven, so as to form a round, close, and compact bunch. The pip is composed of the tube, with its stamens and anthers, the eye, and the exterior circle, containing the ground colour, with its edge or margin. These three should be all well proportioned; and for them it is requisite that the diameter of the tube be one part, the eye three, and the whole pip six, or nearly so. All the admirers of this flower agree that the pips ought to be round, although this is in fact a rare occurrence; and we must be content if they are so nearly round as not to be what is termed starry. The anthers or summits of the stamens ought to be large, bold, and fill the tube well, and the tube should terminate rather above the eye. The eye should be very white, smooth, and round, without any cracks, and distinct from the ground or self colour.

The ground colour should be bold and rich, and equal on every side of the eye, whether it be in one uniform circle, or in bright patches; it should be distinct at the eye, and only broken at the outward part into the edging: a fine black purple, or bright coffee colour, contrast best with the eye. A rich blue or bright pink, is pleasing; but a glowing scarlet or deep crimson, would be most desirable, if well edged with a bright green; but this must seldom be expected. The green edge or margin is the principal cause of the variegated appearance in this flower; and it should be in proportion to the ground colour, that is, about one half of each. The darker grounds are generally covered with a white powder, which seems necessary, as well as the white eye, to guard the flowers from the scorching heat of the sun's rays, which would soon destroy them if they were exposed to it.

Auriculas are propagated by dividing the root, or by rooted slips, and by seed for obtaining new varieties. The best time for taking off slips, or dividing the root, is after the plant is done flowering. The operation is therefore generally performed in July, and the beginning of August.

In order to procure good seed, the healthiest young plants of the most approved sorts are to be selected, and put into pots, where they are to be reared and tended apart from other flowering plants, until the seeds are perfected. Six seedling plants of different sorts may be put into each pot, and thus reared apart; or Knight's method of impregnating the stigmas of one sort with the anthers of another, may be resorted to. The seed generally ripens in June or July, and is to be gathered in single capsules as it ripens, and kept in these till the sowing season, which is January, February, or March. Maddock sows the seed in boxes, covers with very little earth, and puts them into heat, by which means the seeds quickly germinate; while those sown in the open air, are more dilatory and uncertain. The earth must be kept constantly moderately moist, but never very wet. As the spring advances the boxes may be exposed to the open air, shaded from all but the morning sun. As soon as any of the plants appear with six leaves, such are to be transplanted into other boxes, filled with compost; and after a time retransplanted into larger boxes. When they flower, all the best sorts are to be marked and reserved, and the useless ones thrown away. Such weakly plants as do not blow the first or second year, are nevertheless to be preserved; for among these, it not unfrequently happens, that the most valuable flowers are to be found. A great proportion of the seedlings, although the seed was saved from the best flowers, will turn out plain or selfs, which, unless possessed of excellent properties in other respects, or being singularly beautiful in their colours, are of no value, but as common border flowers. As a compost, Hogg uses one part rich yellow loam, or fresh dung earth, one of leaf mould, one of cow dung two years old, and a small portion of river sand. Maddock recommends one half rotten cow dung two years old, one-sixth fresh sound earth, of an open texture, one-eighth earth of rotten leaves, one-twelfth coarse sea or river sand, one-twenty-fourth soft decayed willow wood, one-twenty-fourth peaty or moory earth, and the same quantity ashes of burnt vegetables. This compost is to be thoroughly incorporated, and exposed to the air in an open situation, for a year previous to using it. According to Hogg, the Lancashire growers use horse dung and cow dung indiscriminately, sometimes mixed, sometimes apart; the dung of poultry most frequently, and old decayed willow wood, when they can get it with the mould cast up by moles, taking care that the whole be properly mixed and pulverized. In winter they throw it up in narrow ridges; and when the top of it is frozen they take it off, and so continue to do till the whole of it has been frozen. Paxton uses bone dust, or a very small portion of lime.

The common sorts of auriculas are grown in beds, or in mingled borders; but all the fine flowers are put into pots. The time of transplanting them is immediately after the bloom; and this process should be repeated every year. The plants should be carefully turned out of the pot, and the earth shaken from the fibres of the roots. These should be curtailed if found too long and numerous, together with the lower end of the main root. The lower leaves, if they have turned yellow, should also be cut off, and

the stem examined, especially at its lower part, in case of any unsound spots. If these are found they are to be cut out, and the part stopped up after it has been dried in the sun, with equal parts of bees' wax and pitch, softened with heat.

The new pot is now to be half filled with compost, having previously put a piece of pitcher or oxyster shell, with the convex side uppermost, over the hole in the bottom. The plant is then to be put into the pot, carefully spreading out and covering its fibres with the composts.

The proper depth of planting is within about half an inch of the bottom of the lowest outside leaves. For as the new and most valuable fibres proceed from that part, so they should immediately meet with earth to strike into, or otherwise they will perish. It will likewise encourage the offsets, if there be any, to strike root sooner than they would do if not in contact with the soil. During the summer blow, the auriculas must be placed in a situation shaded from the sun and rains; and in winter, in a situation protected from the weather. A summer and winter stage made of wood, with folding covers, are in use by gardeners. The summer stage should be placed on coal ashes, to protect the pots from the common earth worm; or it may be placed on a layer of open brick work, in order to afford a free circulation of air.

As auriculas and hyacinths bloom about the same time, a pleasing variety is afforded by having their flowers in juxtaposition.

The Carnation (*dianthus caryophyllus*). Natural family *caryophylleæ; decandria, digynia*, of Linnæus. The natural family to which this species belongs, contains a number of flowers possessed of considerable beauty, and esteemed for their fragrant odour, that of the carnation resembling the odour of cloves, though more delicate, and not so pungent. The carnation is indigenous to Britain, but is rare in a wild state; it is found growing plentifully on the southern sides of the Swiss Alps. This garden flower was probably introduced into Britain from Germany or Italy, in which countries it has been long cultivated and esteemed, although it does not appear to have been known to the ancients. In 1597, Gerarde got plants of this flower from Poland. It is now one of the greatest favourites of the parterre. "Of all the flowers that adorn the garden," says Hogg, "whether they charm the eye by their beauty, or regale the sense of smelling by their fragrance, this may justly be said to hold the first rank. The stateliness of its growth, the brilliancy and diversity of its colours, and the sweetness of its perfume, never fail to attract our regard and admiration. The tulip, though styled the queen of the garden, cannot boast of more admirers. They may with propriety be considered the two masterpieces of nature; and though rival beauties, may be said to share the sovereignty of the garden equally between them. Yet it must be admitted that the carnation, independent of its fragrance, has this advantage over its rival, that it continues longer in bloom; and that when planted in pots, it can be removed to decorate the green-house, the conservatory, or the drawing room." They have accordingly found a place in the parterres of the nobility, as well as in the cottage plot of the peasant.

The varieties of this flower are very numerous, and have been arranged into the following classes:

Flakes, having two colours only, and the stripes large, going quite through the petals.

Bizarres, variegated in irregular spots and stripes, with not less than three colours.

Picotees, with a white ground, spotted, or pounced with scarlet, red, purple, or other colours.

Only double flowers are held in estimation. There is a variety called the tree carnation, with suffruticose stems, which may be trained against a wall or trellis, to the height of five or six feet, and will live for six years, flowering every year.

In a fine carnation, the stem should be strong, tall, and straight, not less than thirty, or more than forty-five inches in height. The footstalks supporting the flowers should be strong, elastic, and of a proportionate length. The corolla should be at least three inches in diameter, consisting of a great number of large, well-formed petals; but neither so many, as to give it too full and crowded an appearance; nor so few, as to make it appear too thin and empty. The petals should be long, broad, and substantial, particularly those of the lower or outer circle, commonly called the guard leaves. These should rise perpendicularly about half an inch above the calyx, and then turn off gracefully in a horizontal direction, supporting the interior petals, and altogether forming a convex, and nearly hemispherical corolla. The interior petals should rather decrease in size as they approach the centre of the flower, which should be well filled with them. The petals should be regularly disposed alike on every side, folding over each other in such a manner, as that both their individual and combined beauties may be obvious at the same instant. They should be nearly flat, although a small degree of concavity or inflection, at the lamina or broad end, is allowable. But their edges should be perfectly entire, that is, free from notch, fringe, or indenture. The calyx should be at least one inch in length, terminating with broad points, sufficiently strong to hold the narrow bases of the petals in a close and circular body.

Whatever colours the flower may be possessed of, they should be perfectly distinct, and disposed

in long regular stripes, broadest at the edge of the lamina, and gracefully becoming narrower as they approach the close of the petal, and there terminating in a fine point. Each petal should have one half, or nearly so, of white, which should be pure, clear, and free of spots. Bizarres, or such as contain two colours upon a white ground, are esteemed rather preferable to flakes, which have but one, especially when their colours are remarkably rich, and very regularly distributed.

Scarlet, purple, and pink, are the three colours most predominant in the carnation. The first two are seldom to be met with in the same flower; but the last two are very frequently. When the scarlet predominates, and is united with a paler colour, or, as it sometimes happens, with a very deep purple upon a white ground, it constitutes a scarlet bizarre, of which there are many shades and varieties, some richer, and others paler in their colours, as is the case with all the rest.

Pink bizarres are so called when the pink abounds, and so of the other colours. When the pink flake is very high in colour, it is called rose flake; but there are some so nearly in the medium between a pink and scarlet, that it can scarcely be defined to which class they belong. In addition to these varieties, there is another much esteemed by cultivators, called *picotee*, many of which are very beautiful; and being hardier than the other sorts, are in considerable request. The colours are principally yellow and white spotted; their properties are the same as the other kinds, except that the edges of the petals are serrated or jagged, and the colour is disposed in spots while the others are striped.

The carnation is propagated by layers and pipings, and by seed for procuring new varieties. The most usual method is by layers. This operation is performed when the plants are in full bloom, or as practised by some, when the flowers are on the decline. The process, by wounding the stalks, impairs the bloom, and frequently destroys the parent plant.

A sufficient quantity of hooked pegs, and of compost, being provided, the pot containing the plant to be layed, is placed on a table, and the layers prepared by cutting off their lower leaves; the earth is then stirred, and the pot filled up with light rich mould, not of too fine a grain. The incision is made by entering a quarter of an inch below the joint, and passing the knife up through the centre of it; it is then to be pegged down, and buried not more than half an inch deep. The layers should be pegged down in a dry state, as they are then less brittle, and less liable to break off, than when wet and succulent. As soon therefore as the layers are dressed, the pot should be placed full in the sun for half an hour, in order to render them more flaccid and pliant than they otherwise would be. When the layers are properly rooted, which will be the case with most sorts in about three weeks or a month after laying, provided due care be taken to keep them regularly moist, and to shade them from the heat of the meridian sun; they are then to be cut off from the old plant, with about half an inch of the stalk which connects them with it, and immediately planted in small pots, three or four plants in each, placed round the sides. The pots are to be placed under an arch of hoops, where they can be covered with mats, and protected from heavy rains. In winter they are to be removed under cover of a frame, to protect them from the frost.*

Piping is a more precarious mode of propagation, and the chances of its success depend much on circumstances. It is resorted to when the shoots are too short for laying. A slight hotbed is to be prepared, and covered with four or five inches of light mould. The cuttings intended to be piped, are to have two complete joints. Some also cut off the extremities of the leaves, as in the case of laying; and the pipings, which should be from an inch and a half to two inches long, are thrown into a basin of soft water for a few minutes. The earth on the hotbed should now be moderately moistened, and rendered rather compact; then take a small hand glass, and with it make an impression neatly on the surface of the soil, in order to mark out where to stick in the pipings. These are to be taken singly out of the basin, and put into the earth about half an inch deep, regularly at equal distances from each other, and about an inch within the circular mark of the glass. They are then to be watered gently; and after the leaves are dry, the glass is to be put carefully over them, forcing the edge of it a little into the earth, so as to exclude the external air. The soil should be kept moderately moist, the plants exposed to the morning sun, but shaded from the noon-day by matting; and the glasses are to be occasionally taken off to admit air. If air is not occasionally and freely admitted, the surface of the soil, and the plants themselves, will become mouldy, in consequence of the growth of parasitic fungi.

Raising the seed is rather a difficult process in this climate, owing to the dampness of the autumnal months; it is accordingly generally procured from Switzerland and Germany; and if put into well stopped phials, it will keep sound for years. In raising it in this country, those plants that have few petals, or nearest approaching to single, should be selected, only they should be good of their kind. The pots containing these should be separated from the

* Maddock.

rest, and placed in an open situation, and sheltered from occasional heavy rains; they should be moderately watered. When the bloom is over, and the petals are dry and withered, they should be carefully drawn out of the pod and calyx, so as to allow the seeds to dry and ripen fully. So difficult is it to ripen the seeds, that, according to Hogg, very often not more than one in a hundred plants prove fertile. Seedlings require two years to bloom, and, according to the same florist, the chance of getting one good new flower is as 1 to 100. If a florist raises six new carnations in his lifetime, he is to be considered fortunate. Seeds out of the same flower will be found to produce all the different varieties. The compost used for the carnation is one-half rotten horse dung one year old, one-third fresh loamy earth, and one-sixth coarse sea or river sand. These ingredients are to be mixed together in autumn, laid in a heap about two feet thick in an open exposure, and turned three or four times during winter, so as that the whole may be frozen over. In March the whole should be well mixed and incorporated together, and passed through a coarse sieve. The common sorts are planted in beds or borders; but the finer sorts always in pots. These should be at least twelve inches in diameter at the top, and ten inches deep.

The plants, after being dressed and prepared, are to be put into the pots about the middle of March, or first of April. They are then placed in free, open situations, under an arch of hoops, where mats may be placed to protect them on occasion of heavy rains, or severe weather. When the flower stems have grown to eight or ten inches, they require support by tying them to sticks placed for the purpose. All insects, especially the green plant louse, are to be carefully picked off the stems or leaves, and destroyed. Just previous to the expansion of the flower, the petals are so large and numerous, in some plants, as to burst the calyx at one side. This disfigures the flower, and to prevent this accident, a slip of bladder is to be tied round the calyx, so as to give it support till the petals burst forth at the top. When the first flowers begin to open and expand, they should be covered from the sun and rain by small pieces of paper in the form of an extinguisher, lightly put over them; and when the greater part are in bloom, a general covering should be put to protect the whole.

The petals of the carnation, particularly the high coloured ones, are very apt to return from the striped or variegated, to the original plain; they are then esteemed of little or no value by the florist. When they show a tendency to this, they may frequently be recovered by planting them in a poor dry soil, that will but just afford sufficient nourishment for their existence. The winter treatment of the carnation plants resembles that described for auriculas.

THE PINK *(dianthus hortensis)*. Pinks have only been known as garden flowers from a very modern date; indeed, the garden pink is supposed by many to be only a sub-species, or, perhaps, a cross of the carnation. Some have supposed it to have been produced from the British species, *d. deltoides;* and the pheasant eye pink, from *d. plumarius.*

The cob pink is a large sort, apparently intermediate between the pink and picotee carnation. There are a great number of varieties of the garden pink. A first rate double pink should have a strong, elastic, and erect stem, not less than twelve inches high. The calyx should be rather smaller and shorter, but nearly similar in form and proportions to that of the carnation; while the flower should not be less than two inches in diameter. The petals should be large, broad, and substantial, and have very fine fringed or serrated edges, free from large, coarse, deep notches, or indentures. In short, they approach nearest to perfection when the fringe on the edge is so fine as scarcely to be discernible; and it is even desirable that they should be perfectly rose-leaved, that is, without any fringe at all. The broadest part of the lamina, or broad end of the petals, should be perfectly white and distinct from the eye, unless it be a laced pink, that is, ornamented by a continuation of the colour of the eye, round, bold, clear, and distinct, leaving a considerable proportion of white in the centre perfectly free from any tinge or spot. The eye should consist of a bright or dark rich crimson, or purple, resembling velvet; but the nearer it approaches to black, the more it is esteemed. Its proportion should be about equal to that of the white, that it may neither appear too large or too small.

The general mode of propagating pinks is by pipings, or by layers to preserve rare sorts, and by seed to procure new varieties. The proper time to commence the operation of piping, is immediately previous to, or during the bloom, or as soon as the new shoots are grown of a sufficient length for the purpose. The same method is employed as that described for the carnation. Some gardeners, instead of piping or laying, half separate the young shoots from the parent stock; although this process is apt to injure the latter, and is not to be generally recommended.

There is also a process for procuring new varieties, of impregnating double and semi-double pinks with single kinds, which is thus described by a French florist: "Just before sunrise open carefully the flower to be operated on, and abstract the anthers with a small pincers. About eight or nine o'clock place the ripe pollen upon the stigma of the flower, and repeat this two or three times in the course of the day. If the act of

impregnation has taken place, the flower will fade in twenty-four or thirty-six hours; but if not, the flower will remain in full beauty, in which case the attempt must be repeated. This should always be done in fine serene weather; and care should be taken to defend the impregnated flower from rain and mists. Plants raised from seeds which have been crossed, always bear the form of the mother, but take the colours of the male parent. Fewer seeds are produced by art than by nature alone; and the impregnated flowers are less visited by bees than others."

The common sorts of pinks are planted in borders, and the best qualities in beds; few, except very rare sorts, are put into pots, for in general they thrive best in the open ground. The most appropriate soil is a fresh loam, dug about two feet deep, finely comminuted, and manured with a stratum of cow dung two years old, mixed with an equal proportion of earth. As soon as the pipings are struck, and will bear removal, they are to be planted on a bed of common garden mould, where, in a few weeks, it will easily be discernible which are the strongest plants to remove to the blooming bed. This bed should be raised three or four inches above the surrounding paths; and the plants placed in it in August, or early in September, about nine inches apart from each other. During winter, if the frost is severe, a slight covering will be necessary; and in the ensuing spring, weeding and stirring up the surface of the bed, are all that is necessary. A month before blowing, the bed may be thinned if necessary, leaving all the largest and strongest plants. In these plants all the small lateral buds should be plucked off, in order to ensure a full blow of the central ones, and these should not exceed eight or ten in number. Strong healthy plants, not too large or bushy, and consisting of a capital leading stem in the centre, are the most likely to produce the best flowers. Those buds likely to burst at the side of the calyx, should be tied and supported, as described for the carnation; and sticks should be put into the ground, to which the large stems are to be tied for support. Pinks transplanted in spring never show such a fine blow as those transplanted in September. They should be moved every two years.

THE VIOLET *(viola)*. Natural family *violaceæ; pentandria, monogynia*, of Linnæus. This is a genus of pretty flowers, of which there are a number of species, distinguished by their five-petalled corolla, generally blue, purple, and white, with these petals disposed somewhat in the butterfly form. The leaves vary according to the species, being heart-shaped in some, in others ovate, sagittate, pedate, &c. Some are annual, others perennial; and they are natives of Europe, Asia, and America.

Several species are indigenous in Britain, as the sweet violet, the hairy, the marsh, the dog's violet, and the pansy, or heart's-ease. Violets were known to the ancients, and named after Io, fabled to have been turned into a cow by Jupiter. The ancient physicians employed the roots and leaves in medicine; but in modern practice the flower only is occasionally employed as a test of acids, and for imparting a pleasing colour to tinctures. As garden flowers, the violet and pansy are much prized both for their beauty and the grateful flavour of the odorous species.

The *Sweet Violet (v. odorata)*. This is a favourite flower from its delicious fragrance, and the early period at which it appears. It is a native of England, and every part of Europe, growing in a loamy soil in woods and thickets, and on warm banks. Desfontaines saw it frequently in Barbary, in the palm groves about Tassa and Cossar, the blue and white growing promiscuously, and flowering in winter. Hasselquist found it in Palestine, Thunberg, in Japan, and Laureiro, in China, near Canton.

It is a perennial creeping plant; the leaves are cordate and smooth; while the hairy violet *(v. hirsuta)*, which nearly resembles it, has the leaves and footstalk hairy; the latter also is inodorous. The petals of the sweet violet are either blue, purple, or white. The double kinds most esteemed are the purple and the Neapolitan variety, called the single Russian, which commence to flower in autumn in the open air, and continue so even during the frost of winter.

The sweet violet grows best in a loamy soil, and may either be planted in beds in warm situations, in the open ground, or under glass frames. The Neapolitan is well adapted for forcing in pots. The violet is frequently alluded to by the ancient poets as a remedy for the cure of wounds, and was used for this purpose by the Greeks and Arabians.

The *Pansy*, or *Heart's-ease (v. tricolor)*. This name was originally confined to the *viola tricolor;* but it is now extended to other species, as the *lutea, grandiflora, amœna*, and the hybrids, produced by mingling these species together. The tricolor is an annual, with stalks from four to six inches in height; the leaves variously shaped, being ovate, or elliptical, according to position, and with compound stipules. The petals are variously coloured. In the wild species the two uppermost are generally purple or red, and the others variegated, with a yellow ground.

The cultivated varieties are at least a hundred. The prevailing colours are purple and violet, each with many shades. They are in flower from the beginning of June till July; the midsummer heat interrupts their blooming for some time; but after the middle of August they commence again, and continue with a perpetual

succession of varied and beautiful flowers, till checked by the winter frosts. The finest pansies should have large, round petals; the flower forming nearly a circle, one inch and a quarter in diameter. The colours should be brilliant, distinct, and permanent; the eye rather small, and not deeply pencilled, and the stigma filling the open part of it. The flower stalk should be strong and erect.

The propagation of pansies is by cuttings, or seed, either of which may be accomplished with the greatest ease in common garden soil. The seeds may be sown early in spring, under hand glasses, or in a common frame; and the plants may be first pricked out under glass, and afterwards transplanted into beds in the open garden, or put into pots. The situation should be open to the east or west; the surface should be rather below the neighbouring ground, so as to retain moisture, and be cool; and the soil should be a sandy loam, well manured.

LOBELIAS. Natural family *campanulaceæ; pentandria, monogynia*, of Linnæus. This genus of splendid plants is called after Lobel, a French botanist, who came to England in the reign of James I. There are many species of this family, some of which are aquatic plants, or grow in very moist situations, as the water lobelia, *dortmanna*, and the long-flowered *longiflora*. The leaves are generally oblong, lanceolate, or linear; the prevailing colour of the corolla is red. Three beautiful garden species are known under the name of cardinal flowers.

The *Common Cardinal Flower (l. cardinalis)*, is a native of Virginia, where it grows wild in abundance, by the sides of rivers and ditches. It was introduced into Britain in the year 1629, and was then very much admired. Justice describes it as "a flower of most handsome appearance, which should not be wanting in curious gardens, as it excels all other flowers I ever knew, in the richness of its scarlet colour."

This plant is propagated in the usual way, by offsets and cuttings; but those raised from seed, produce the strongest plants. Soon after the seed has ripened, it is to be sown in pots of rich earth, placed under the protection of a frame. Next spring the plants make their appearance, and after they have acquired two or three leaves, they should be put out into separate pots; and as they acquire bulk, still farther transplanted during the season. They should have an eastern exposure, and a liberal supply of water. In the second season they will flower, and if protected from the too great influence of the sun, will continue a long time in full beauty. The roots do not last above two or three years, and thus a constant succession of young plants is necessary.

The *Fulgent Cardinal Flower (l. fulgens)*. This species is a native of Mexico, and was introduced into England in 1809. It is an aquatic plant, and will even endure the severity of our winters, if planted by the side of ponds or cisterns. It flowers in July and August. It may be propagated by suckers or cuttings, which strike with great facility in any shady situation. It may also be raised from seed, which should be sown as soon as it ripens, on the surface of moist earth in earthen pans, taking care not to cover up the seed with earth.

The plants will come up in spring, and flower the second year. It is necessary to shelter the pans during the winter. By a succession of transplantings into larger pots, magnificent plants of this species may be obtained, some of them attaining the height of five feet, and upwards.

The *Splendid Cardinal Flower (h. splendens)*, is also a native of Mexico, and was introduced into Britain in 1814. It is to be treated in the same manner as the others.

The *Blue Cardinal Flower (l. syphilitica)*, and several other species, are natives of America. They all require the same mode of treatment, and may be raised without much difficulty. The *l. syphilitica* was said to be employed as a medicinal plant by the North American Indians, in the cure of syphilis. Its virtues, however, have not been confirmed by the trials of European physicians.

The dwarf varieties of lobelias are of two kinds, those with blue flowers, and those with white. They are easily raised in borders, and have a very showy appearance during the greater part of the summer. They are propagated by cuttings taken early in spring, placed below glasses until they set, and then transplanted into open borders as soon as the weather admits.

BELL FLOWER *(campanula)*. Natural family *campanulaceæ; pentandria, monogynia*, of Linnæus. This is a genus of plants with numerous species, distinguished by the bell-shape of the corolla; hence the name derived from *campana*, (a bell). Almost all the species have long white roots, of an esculent quality; that of rampion *c. rapunculus*, is used as food in France and Italy. Many of the species are showy garden flowers. The common Scottish blue bell, *c. rotundifolia*, is a well known wild flower.

Pyramidal Bell Flower (c. pyramidalis). This splendid species is a native of Istria and Savoy, and was first cultivated in Britain by Gerarde. For a long time it was a fashionable flower in the halls of the nobility, and was usually trained in a spreading, fan-shape, so as to cover the fire place in summer; and for this purpose it is still esteemed in Holland. It has, however, been greatly superseded as a fashionable flower in this country, by other more novel plants, as the lobelia. It is, however, when trained to a great height, by successive trans-

plantations into larger pots, a beautiful object, with its tall pyramidal stem, on which, for at least two months, appear a succession of blue bells.

It thrives best in a rich light soil, without any animal manure; and may be propagated by seed, by cuttings from the stem, or by division of the roots, which last affords the strongest plants in the shortest time. The proper time for dividing the roots is after the bloom is over, in September. The sections are then to be planted in pots, and protected by a frame during the winter. In spring they are to be transplanted into small pots, and gradually changed into larger ones. According to Miller, the plants raised from seed are always the best. The stalks rise more vigorous, and higher, and produce a greater number of flowers. Good seeds are to be obtained by placing a strong flowering plant in a warm situation, against a wall, or under a glass case. Soon after the seeds are ripe, and gathered, they are to be sown in pots containing light earth, and then put under shelter for the winter. The plants appear in spring, and make progress during the summer. When the leaves decay in October, they are to be transplanted into beds of light loamy earth, without any mixture of manure. In this bed they are left for two years, being protected in winter by rotten tan. They are then to be removed to their final destination in September or October, and the following year being the third from sowing, they will flower. The plants of this, as well as many other species which have been propagated by roots, do not so readily bear seed as those which have been raised directly from seed.

The *Canterbury Bells (c. medium)*, is a well known garden flower, with double and single varieties; blue, red, purple, and white coloured. It is a biennial, of very easy culture, and may either be sown in autumn in beds, where it is to remain; or in spring, for transplantation.

The *Clustered Campanula (c. glomerosa)*, is a rock or pot plant, and requires a dry poor soil, in order to bring out the vivid tints of the corolla. It is also of very easy culture.

The Double Rocket. Natural family *cruciferæ; tetradynamia*, of Linnæus. This is a biennial, or imperfect annual, a native of Italy, and introduced into Britain by Gerarde, in 1597. There are two varieties, the white and purple, both forming a spike of double flowers, about twelve inches in length. They are beautiful, fragrant, and durable flowers, and give out their odour more sweetly in the evening than during the day. Although it is of easy culture in country gardens, yet it will not thrive near large cities, as London and Paris; so that both these capitals are supplied with it from the provinces.

It grows very luxuriantly in a clayey soil; but a lighter texture of soil is more favourable for the full development of its flowers. The best mode of propagating these plants is the following. When the flower is beginning to fade, cut down the stalks and divide them into ordinary lengths of cuttings; next cut off the leaves, and smooth the ends, then make three slits with a knife in the bark or rind, lengthwise, so as to separate or raise the bark for half an inch in length. When the cutting is inserted in the ground, the loose bark naturally curls up; and it is from this bark that the young shoots proceed. The partial separation, and the turning up of the bark, seems to promote a tendency to throw out roots. The cuttings may be put into flower pots, as they may thus be sheltered during winter with more ease; or they may be placed in the natural earth, provided the soil is light and fresh. Covering them with a hand glass, will forward the rooting of the cuttings; or they may be put on a hot bed, which will equally facilitate their growth. The same florist * recommends a similar plan of treatment for stock gelly-flowers, and double wall-flowers.

Chrysanthemum. Natural family *compositæ; syngenesia, superflua*, of Linnæus. This genus is well known as containing some of our most showy corn weeds, as the ox-eye, daisy, and corn crysanthemum, as well as our most showy varieties of garden flowers.

The *Chinese Crysanthemum (c. Indicum)*, is the finest of this family. It is a native of India, and a particular favourite with the Chinese, from whence we have derived all our varieties. It was first introduced into this country in 1764, and soon became a favourite in our gardens. It blows late in autumn, and may be preserved in the conservatory till the middle of winter, at a period when few other flowers are in perfection.

There are at least fifty known varieties of this flower, which have been classed under the following heads :—

Ranunculus-flowered, yellow, white, brown, bluish, buff, pink, and light purple.

Incurving ranunculus-flowered, black, bluish, pink, orange, red, and white.

China aster-flowered, yellow, red, crimson, pink, black, and white.

Marigold-flowered, golden-yellow, with bronzed back, yellow, lotus-flowered, pale, buff, purple.

Tassil-flowered, yellow, salmon-coloured, lilac, purple, and white.

This flower is of very easy culture, and is propagated by dividing the root by suckers, and by cuttings. In the beginning of April cuttings are taken from the top shoots of last year's plants, and put into pots containing fresh loam, sand, and bog, or leaf mould. These cuttings should be about three inches in length, and smoothly

* Robertson Caledon. Mem. vol. 2.

cut across at a joint. At first the pots are to be put into artificial heat till the plants root, and then to be placed in the open air, moving them into larger pots as the plants advance in growth. They should be watered with liquid manure, and about the month of June the tops of the plants should be nipped off, in order to make them grow bushy.

Many of the varieties may be raised in the open border in warm sheltered situations, the best soil being two-thirds of turfy loam, and one third of leaf mould.

During winter the roots require protection, and they need to be renewed about every two years; for as they increase much in size by suckers from the roots, the plants, if left for a long period, become unsightly, and produce small and imperfect flowers. The early flowering varieties are the hardiest and most suitable for the open border.

The marygold (calendula officinalis.) This well known flower, belonging to the same natural family as the foregoing, has been a denizen of the garden border from the earliest times. Though common, and hardy, and prolific as any weed, its deep orange disk is by no means devoid of beauty. Formerly it used to be employed in broths and soups, partly to give these a colour, and partly to give the peculiar flavour and warm aromatic taste which belongs to the flower. It had also many medicinal virtues assigned to it, which modern opinions have not confirmed. The flower of the marygold, according to Linnæus, is open from nine in the morning till three in the afternoon. There are double, lemon-coloured, and prolific varieties. A distilled water, a kind of vinegar, and a conserve, are prepared from the flowers.

A number of species of this genus are indigenous to the Cape of Good Hope; some of which are showy annuals.

The Daisy (bellis perennis), is also a well known flower. The garden varieties are double, from the stamens being converted into petals of the corolla. There is also a singular variety called the *Hen and Chicken's Daisy*, where small additional flowers grow out from the original central one. The daisy continues many months in flower, enamelling alike the meadow and the garden border with its pleasing and familiar face.

There are other two species, the large Portugal daisy, *(b. sylvestris)*, and the annual.

Asters. This genus, belonging to the natural family *compositæ*, contains a great number of different species. All the flowers are star-like, hence the name, and there is a peculiarity in the style which distinguishes the genus. The colours are various. From the lateness in the season at which they bloom, they have obtained the name of Christmas daisy. There are seven species commonly cultivated in gardens which bloom in September, eleven which flower in October, and three which continue from November till Christmas. They are very easily cultivated, and will grow in any kind of soil. The greater number are natives of America, but some of the species are found over most regions of the globe.

The China Aster is a well known annual, some recent varieties of which have been introduced from Germany, of large size, with quilled and striped flowers. The seed should be sown the first week of April, either in pots or seed pans, and placed in a cold frame. When the plants come up, and are of a proper size, they may be transplanted to open beds and borders.

THE LUPINE. The natural family *leguminosæ*, to which this genus belongs, affords many beautiful species of garden flowers. About twenty species of the lupine have been cultivated for this purpose, and afford beautiful border ornaments, with a variety of colours, blue, yellow, rose-coloured, &c. They are all of very early culture, being reared from seeds the same as the common pease and beans.

STOCK GILLY FLOWER *(mathiola.)* Natural family *cruciferæ*. This genus was named after Mathiola, an Italian physician. There are several species natives of Europe and of Barbary. Two species, the common gilly flower *(incana)*, and *sinuata*, are indigenous to Britain. They have been long favourite ornaments of the flower garden, the double species being esteemed for the beauty and deep tints of the flower, and for its delightful odour. Of the common or ten weeks' stock, and the smooth-leaved, *(glabra)* there are not less than one hundred varieties, generally called German stocks. The simple or Brompton stock *(simplicicaulis)* is a biennial, of which there are also several varieties. The ten week stock, in order that it may flower the same year, should be raised in a hot-bed, and transplanted as early in the spring as the state of the weather will permit. The Brompton, on the other hand, should not be encouraged to flower till the second season, and on this account may be sown in the open air in April or May, and transplanted in July to the situation where it is intended to remain. It is of importance that all the species of this genus should be transplanted when they are very young, because, having fusiform roots, and fine side fibres, they seldom recover from the check which they receive from being transplanted, after they are two or three months old. The chance of double plants is often very precarious. It is said that those seed plants which have more than the usual number of petals, that is, six or seven instead of four, generally produce double flowers when the seed is again sown. It would be well, therefore, for the florist to mark

such plants, and preserve the seed to be sown separately.

The Wall Flower (cheiranthus cheira.) This is a genus allied to the former. The delightful fragrance of the common wall flower has always rendered it a favourite, although it is possessed of little beauty. There are several species, and several double varieties. All are of very easy culture. The rock wall flower, *(scoparius)*, and indeed all the species thrive well on rocks and walls where the soil is poor and arid. On this account, it becomes a flower well suited to form an ornament, and to conceal blemishes in any part of the garden grounds. It has this advantage also of being a hardy evergreen, standing out even our severe winters. It has sometimes been planted in pasture lands, its bitter qualities having been found a preventative of the rot in sheep.

Balsam *(impatiens balsamina.)* Natural family *balsamineæ; pentandria, monogynia*, of Linnæus. This is one of the most beautiful of garden annuals. It grows to one or two feet in height, with a succulent branchy stem, serrated leaves, and a cone of finely variegated carnation-like flowers. The prevailing colours of the petals are red and white, the former extending to every shade of orange, purple, scarlet, lilac, pink, and flesh colour. On the slightest touch the seed capsules, when ripe, burst and scatter the seeds around. Hence the name *impatiens* was applied to the family. It is a native of the East Indies and Japan, where, according to Thunberg's account, the natives use the juice prepared with alum for dyeing the nails red. It was first cultivated in England by Gerarde, in 1596.

One species, *(b. nolitangere)*, is a native of Europe. During the day the leaves of this species are expanded, but at night they hang pendent, contrary to what usually takes place in plants which, from a deficiency of moisture, or a too great perspiration from heat, commonly droop the leaves during the day. No animal but the goat is said to eat this plant. The garden balsam is exceedingly apt to run into varieties, the seed from one plant scarcely producing two alike. Double flowers are those esteemed, and the most prized are the striped carnation-like flakes or bizarres. It is generally raised by seed, though in this way no varieties can be depended upon being transmitted; sometimes although rarely, varieties are propagated by cuttings, which, however, do not readily set. Seed ripens easily in semi-double plants, and should not be less than three or four, or even nine years old, before it is sown, as it has been found that new seed rarely produces double flowers. The best soil is a rich loam, and the sowing may take place at any time from March to the end of April. The seed is to be sown very thin in pots, which are then to be placed in a hot bed as near the glass as possible. When the plants attain a height of five inches, they are to be transplanted into larger pots, one in the centre of each. As soon as the roots have filled them, the plant is to be moved into a larger; and this process is to be repeated three or four times till the last pots are eight or more inches in diameter, still keeping the plants in a hot-bed. Balsams so treated will grow to the height of four feet, and fifteen feet in circumference, with side branches from top to bottom, all covered with large double flowers.

The Cock's Comb (celosia cristata). The amaranthus *tricolor*, the globe amaranth, and most other tender annuals, may be treated in a similar manner, and with similar success. In October, 1820, Mr Knight sent to the Horticultural Society a cock's comb, the flower of which measured eighteen inches in width, and seven inches in height, from the top of the stalk. It was thick and full, and of an intense purplish red. This was produced by means of retarding the growth of the flower stalk. The compost employed was of the most nutritive and stimulating kind, consisting of one part of unfermented horse dung fresh from the stable, and without litter, one part of burnt turf, one of decayed leaves, and two of green turf, the latter being in lumps of about an inch thick, in order to keep the mass so hollow that the water might have free liberty to escape, and the air to enter. The seeds were sown in spring rather late, and the plants put first into pots of four inches diameter, and then transplanted to others a foot in diameter, the object being not to compress the roots, as that has a tendency to accelerate the flowering of all vegetables. The plants were placed within a few inches of the glass, in a heat of from 70° to 100°. They were watered with pigeon-dung water, and due attention paid to remove the side branches when very young, so as to produce one strong head or flower.

The Cyclamen. Natural family *primulaceæ; pentandria, monogynia*, of Linnæus. This is a genus of pretty little annuals, with cordate or orbicular leaves, twisted flower-stalks, and beautiful five petalled flowers. The root is a round flattened bulb the size of a pigeon's egg, and in the north of Italy the swine feed on them. When the flowers fade, the pedicles twist up like a screw, inclosing the germen in the centre, and lying close to the ground among the leaves, remain in that position till the seeds ripen. The plants, from their neat small size, are peculiarly suited for pots for the drawing-room in spring. The ivy-leaved is very fragrant, but scarce and delicate. The Persian ripens seeds freely, and may thus be easily increased. They should be sown immediately after they are ripened, and kept in a frame or greenhouse till the first of May. They may then be transplanted

into a bed of light garden soil, and covered with a frame till midsummer. By the following autumn, they will be found strong vigorous plants, when they may be taken up, potted singly in very small pots, and placed in the greenhouse, where they will flower beautifully, producing from fifty to eighty blossoms from a single bulb. The round-leaved *(coum)* ripens its seeds in May, when they should be immediately sown in pots, and kept in the greenhouse, where they will flower in the following season.

Verbena. Didynamia Angiospermia, Linn. A family of weedy plants, with the exception of the rose and Lambert's vervain. The officinal or common vervain was held sacred among the ancients, and used at their sacrifices, and by ambassadors in making their leagues and national agreements. The others are pretty half hardy perennial garden flowers. They are propagated by cuttings, kept through the winter in small pots, and then when the frost is over, planted in the open air. They thrive best in a light rich soil, and flower during the summer.

Mignonette *(reseda odorata)*. Natural family *resedaceæ; dodecandria, trigynia*, of Linnæus. The very agreeable odour of this little unpretending plant, has rendered it a universal favourite among all nations and classes. It is a native of Egypt, but bears this climate perfectly well, and brings its seeds to maturity. The inflorescence of this plant, and the family to which it belongs, is somewhat remarkable; and is thus described by Professor Lindley.* "The usual idea of the flower of *reseda* has been, that it is furnished with a calyx of a varable number of divisions, with as many petals, producing from their surface certain anomalous appendages; and with an ovary and stamens, inserted in a great fleshy body, called nectary by Linnæan botanists, squama by others, and raised to the rank of a distinct organ by Mirbel, under the name of *gynophore*. To us, however, it has always appeared that this could by no means be the real structure of the plant, and that by a slight alteration of terms, it not only might be much more satisfactorily explained, but its real affinity ascertained with some degree of probability. For even allowing for a moment an analogy between the nectary of this plant, and the discus of others, particularly of some *liliaceæ*, there is still a great difficulty remaining to be overcome in the anomalous structure of the supposed petals, of which we can imagine no possible explanation. We are therefore of opinion that a much more natural mode of understanding *reseda*, is to consider it as having compound flowers, taking the calyx of anthers for an involucrum, their petals for neutral florets, and their nectary for the calyx of a fertile floret in the middle. In support of this opinion, we may observe, in the first place, that there is a difference in the time of expansion of the neutral florets, and of the stamens of the fertile one, the former being quite open in very many capituli before one anther of the latter has burst in a single flower. Secondly, that there is an evident analogy between the appendages of the neutral florets, and the stamens of the perfect florets, inasmuch as in the mignonette those of the upper sterile florets are of nearly the same number as the real stamens; because, in *reseda alba*, and some others in which a union of filaments takes place in the perfect floret, there is a corresponding, but more complete union of the sterile appendages, and because occasionally in the mignonette, stamens are changed into bodies altogether similar to the sterile appendages; and in *reseda phyteuma*, the same appearance is always assumed by the perfect stamens, after the anthers have performed their functions. Thirdly, that there is an equal analogy between the calyx of the neutral florets, and that of the perfect floret; because both have a peculiar glandular margin, the same form, both produce their stamens from their surface; and because the upper edge of the calyx in sterile florets, has the same relation to the axis of each particular head, as that of the perfect floret has to the axis of the whole inflorescence. Fourthly, that there is no instance of the same analogy existing between the discus and petals of other plants. We may also observe, that in *reseda phyteuma*, there is a campanulate tube to the calyx, into the upper edge of which the stamens are inserted.

There is a sub-biennial shrubby variety of the *reseda odorata*, called tree mignonette, rather more odorous than the common sort, and which is well suited for the drawing room. If left to itself, it scarcely can be distinguished as a distinct variety; but trained against a wall, or to a stick, it may be made to assume a shrubby appearance.

Mignonette being so much in demand as a chamber flower, it is of importance to have a succession of plants in all seasons. For this purpose, to obtain a winter supply of fresh, strong plants, the seed should be sown in the open ground in the end of July; by the middle of September, the plants from this sowing will be strong enough to be removed into pots. For a week after this removal they must be shaded, after which they may be freely exposed to the sun and air, care being taken to protect them by frames from damage by heavy rains, and from injury by early frosts, until the beginning of November, at which time many of them will show their flowers; and they should then be removed to a greenhouse or conservatory, or to a warm window in a dwelling house, where they

* Collectana Botanica.

will branch out, and continue to blow until the spring. The crop for March, April, and May, should be sown in small pots not later than the 25th of August; the plants from this sowing will not suffer from exposure to rain whilst they are young, they must, however, be protected from early frosts; like the winter crop, they are to be thinned in November, leaving not more than eight or ten plants in each pot; and at the same time the pots being sunk about three or four inches in some old tan or coal ashes, should be covered with a frame, which it is best to place fronting the west; for there the lights may be left open in the evening to catch the sun. The third or spring crop, should be sown in pots not later than the 25th of February; these must be placed on a frame on a gentle heat, and as the heat declines, the pots must be let down three or four inches into the dung bed, which will keep the roots moist, and prevent their leaves turning brown from the heat of the sun in April or May. The plants thus obtained will be in perfection by the end of May, and be ready to succeed those raised by the autumnal sowing.*

An early and abundant blow of mignonette may also be obtained by using a common box, placed in the window sill, in a warm situation exposed to the sun. In early spring this box should have a glass frame fitted as a covering, to be removed in summer, and which can be obtained at a very moderate expense. About the middle or end of February fill this box with fresh light mould, to which add a little sand, and a sprinkling of lime or pounded chalk, or whiting. Then sow the seed pretty thick, and cover it over with a portion of the finely pulverized mould. The box should be kept inside the window until the plants appear, and then put it outside in March, taking care to cover it up in severe weather, and in frosty nights. As the plants advance they are to be thinned out, air admitted in the sunny part of the day, and a sufficient supply of water given, so as to keep the mould moist. The glass frame may be removed in April or May, at the end of which latter month the plants will begin to flower; and if properly tended and watered, the blow will continue till November. Mignonette requires the sun and air, in order to produce its full and perfect odour; and, on this account, even the pots of this plant should be generally exposed to the open air.

A few seeds of *convolvulus minor*, *clarkia pulchella*, or other annuals, interspersed through the mignonette box, affords a pleasing variety.

The tree mignonette is also propagated by seed, or it may be increased by cuttings, which will readily strike root. The young plants should be put singly into small pots, and brought forward by heat, that of a gentle hot-bed being the best. As they advance they must be tied to a stick, taking care to prevent the growth of the smaller side shoots by pinching them off, but allowing the leaves of the main stem to remain on for a time, to support and strengthen it. When they have obtained the height of about ten inches, or more, according to the fancy of the cultivator, the shoots must be suffered to extend themselves from the top, but must be occasionally stopped at the ends, to force them to form a bushy head, which, by the autumn, will be eight or nine inches in diameter, and covered with bloom. Whilst the plants are attaining their proper size, they should be shifted progressively into larger pots, and may ultimately be left in those of six inches in diameter at the top.

* Kishon. Hort. Transac., vol. 2.

WOODROOF (*asperula odorata*). Natural family *rubiaceæ; tetrandria, monogynia*, of Linnæus. This is a plant which grows wild in woods and thickets, and has been admitted into the garden from the beauty of its whorled leaves and simple blossom, but chiefly from the fragrant odour of the leaves. This odour is only perceptible when the leaves are crushed by the fingers; but when dried, they give out their peculiar odour very strongly, and for a long period. They are used to scent clothes, and also to preserve them from the attack of insects.

This plant will grow under the drip of trees, or in very shaded places, and thus may become a pleasing ornament in situations where other flowers will not thrive. It is also frequently planted in rock works.

THE HOLLYHOCK (*althæa rosea*). Natural family *malvaceæ; monodelphia, polyandria*, of Linnæus. Several species of the mallow are common weeds in Europe. The hollyhock is originally a native of China; but it thrives perfectly in the open air in this country; and forms a very ornamental autumn flower in shrubberies and cottage borders. There are nearly twenty varieties of this species, characterized by the tints of yellow, red, purple, and dark purple, approaching to black. They are easily raised from seed, and will grow in any common garden soil.

THE HYDRANGEA. Natural family *saxifrageæ*, or *hydrangeæ; decandria, digynia*, Linnæus. This is a genus of marsh or aquatic plants, and hence the name is derived from a Greek compound signifying water-vessel. Four of the known species are natives of America; and one, the garden hydrangea (*h. hortensis*), is extensively cultivated in the gardens of China and Japan, although it has not been hitherto found in a wild state. It was introduced into the gardens of Kew, by the late Sir Joseph Banks; and for a long time was a fashionable and favourite plant from the great beauty and size

of its flowers. It has now somewhat waned in public esteem, and given place to other novelties. It is a shrubby, deciduous plant, with elliptical leaves, narrowed at each end, and toothed. The flowers are monstrous, and almost always barren; and the petals have the peculiarity of changing their colour, according to their age, and the nature of the soil. It is decidedly an aquatic plant, and one of large size, will consume in warm weather ten or twelve gallons of fluid daily. It has been supposed that certain chemical agents, especially those of an alkaline and aluminous nature, when mixed with the soil, have the effect of changing the colour of the petals from a pink or rose colour, to a deep blue and purple. Accordingly, it has been found that the yellow loam of Hampstead heath, and some other places, and some sorts of peat earth, are found to produce this effect, probably from containing a portion of sulphate of aluminum. Dr Daalen of Antwerp found that turf ashes, and still more effectually the ash of the Norway spruce, the wood generally used as fuel by him, applied to the roots of hydrangea, produces the blue colour of the petals. A Russian gardener has found that the finest blue is produced by planting the hydrangea in a mixture of clay, and a peculiar sort of bog earth, which is found in the neighbourhood of St Petersburgh. The two soils are intimately mixed, and are passed through a fine seive. Another mode practised by the same gardener, is to add one table-spoonful of alum, to as much common garden earth as will fill a moderate sized pot; but the blue so produced is never so perfect as that from the bog earth and clay. Busch also asserts, that the blue colour can be produced by watering the young plant the summer before flowering, with alum water. According to another authority, by putting the plant into a pot containing a mixture of sandy loam, and fresh sheep's dung, and watering with an infusion of that dung, the same effect will be produced. A mixture of oxide of iron in the mould, is also said to impart the blue tinge.

The hydrangea is propagated by cuttings; and in order to have a succession of young plants each year, in the beginning or middle of July, a certain number of shoots with three or four joints, are to be selected, cutting them off close to the joint, which is at the bottom of the shoot. These are to be planted in rich earth in a warm border, and covered with a hand glass; they should be shaded during the middle of the day, and sprinkled with water two or three times a week in the evening, so as to keep them always moist, the glass being kept close over them at all times. By the end of August they will be well rooted, and then, or early in September, they must be put singly into small pots, and placed under a frame, which at first must be shut up close, and if assisted by a temperate heat, so much the better. In the frame they are to be shaded and watered regularly till the middle of October, when they are to be taken into the green-house for the winter, where they should be watered almost once a week. In May or June following, they may be planted out into a bed of rich mould in the open ground, to remain there till September, when they are again taken up and potted, and treated as in the preceding winter. Instead of turning them out again next spring, they may be retained in pots; but they must be shifted twice during the summer. By either method strong plants will be formed, fit for forcing or turning out in the succeeding spring. They will thrive in open, warm borders, and endure the winter if the roots are protected from frosts. They should be supplied abundantly with water, especially at the period when they are coming into bloom. The most approved soil is a compost of loam and bog earth, or leaf mould, with a little sand well incorporated together. In this they will produce red flowers. If blue are desired, a mixture of Hampstead loam, or wood ashes, or alum, or oxide of iron, as already mentioned, is to be used.

This plant may also be propagated by layers, using the same process as that directed for carnations. The oak-leaved hydrangea *(h. quercifolia)*, is also an elegant plant. It is a native of Florida.

Calceolaria, or Slipper Worts. Natural family *scrophularineæ; diandria, monogynia*, of Linnæus. This genus of pretty green-house flowers came originally from Chili and Peru, and have become great favourites with the public. The corolla is pouched at the lower extremity, and assumes a form not unlike a common slipper; hence their name has been derived. There are numerous species and varieties.

C. corymbosa and *paralia* are herbaceous plants, of great beauty, but somewhat difficult to propagate. *C. bicolor*, and other branching shrubby kinds, are of easy culture. These may be raised from seed sown in spring, or from cuttings, first put into a hot-bed early in the season, and then planted out into warm borders. Some hardy kinds will stand the winter if protected by shelter; and others of the shrubby kind may be trained as standards.

Fuchsia. Natural family *santalaceæ; octandria, monogynia*, of Linnæus. The fuchsia is so named after Leonard Fuch, a German botanist. It is a native of Chili and Mexico, and was recently introduced into this country. The handsome form of the pendant flowers, their vivid colours, and the numbers which successively during the greater part of the season adorn the branches, render this flower a beautiful ornament of the conservatory or parlour win-

dow. There are several species, and numerous hybrids and varieties. The scarlet fuchsia *(f. coccinea)*, has the leaves in threes, and serrated; the peduncles axillary, and one-flowered. *F. gracilis* has the branches slightly downy, the leaves opposite and smooth, the flowers much longer than the leaves. *F. excorticata* has the leaves ovate, and placed alternately. The box-thorn leaved *(f. lycioides)*, has ovate, lanceolate leaves, generally in threes, and the sepals reflexed. All are easily propagated by cuttings. These are to be first raised in the green-house, and then transferred into pots, where they may be kept for two or three years, till they have acquired the size of shrubs, when they may be turned out into the open air at the commencement of summer, and removed again to the green-house in winter. One of the hardiest species *(f. virgata)*, will thrive well in the open air, in a warm sheltered exposure.

When fuchsias attain the height of four or five feet, they become splendid plants, and afford a succession of beautiful flowers. The flowers of the *longiflora* are remarkable for their great length.

Geraniums, or Pelargoniums. Natural family *geraniaceæ; monodelphia, decandria*, of Linnæus. This genus obtains its name from the Greek word signifying *crane's bill*, the seed capsule, with its beak, bearing a resemblance to the long bill of the crane. Many of the species are European plants, and are mere weeds; most of the green-house species are from the Cape of Good Hope. There is great diversity in the form and habits of the different species. Some have tuberous roots; while others are devoid of tubers. Some are devoid of stem, or have an herbaceous or half shrubby stem; the leaves are simple, pinnate, or decompound in the stemless kinds; or entire, toothed, lobed, or pubescent in the shrubby species; and generally odorous, especially when pressed between the fingers. In the majority of geraniums the flowers are odourless, especially those of the more showy kinds; while some of the simpler, and more unpretending blossoms, diffuse a grateful odour, especially during night. The most beautiful flowering geraniums, or pelargoniums, as they are sometimes called, are hybrids, which have been obtained by crossing different species, as first practised by Sweet. The flowers are of various colours, white, blueish pink, purple, orange, scarlet, crimson, all of various shades and depths.

Geraniums are usually propagated by cuttings; but all the kinds ripen their seeds in this country, and these, when sown, frequently produce new varieties.

Most of the plants usually flower in spring, or early in summer; and if the seed is ripe by midsummer, it may be immediately sown in pots of light rich earth. These pots are to be placed in a gentle hot-bed, and shaded. The plants will soon make their appearance, and should be transplanted singly into pots as soon as they show two proper leaves. If kept under a frame, several will flower in the following spring and summer, and the remainder in the following season.

The shrubby species grow most readily by cuttings. These should be taken off at a joint where the wood is beginning to ripen, laid in the shade for an hour or two till the wound heals, and then planted in sandy loam, and placed in a gentle heat. The hardier sorts will, however, strike freely in the open air in any shady situation, without being covered with a glass. Cuttings of the roots of many species also strike readily; and the fibrous rooted sorts may be multiplied by simply dividing the roots. From the latter end of March till the middle or end of July, cuttings of all the common kinds may be put into the ground with success.

The soil best suited for geraniums is a rich light mould, equal parts of sandy loam, and well rotted dung, in a little leaf mould and sand. As they are rapid growers, the pots require to be examined in spring and autumn, and the roots and top reduced, or the plant shifted into a larger pot. In general, the shrubby sorts should be kept low and bushy, by pruning; for when they are allowed to grow tall and straggling, they are very unsightly, and besides, do not throw out so many flowers. Some of the herbaceous sorts may be considered as frame plants, but the greater number require the green-house; and some of the very succulent sorts do best in the dry stove.

When an extensive collection of geraniums is kept, it is recommended to have a house entirely devoted to their culture, with a roof so constructed as to admit as much light as possible; the stage over which the plants are placed should also be near the glass, and there should be ample means for giving air and heat. Most of the species require rather more heat during winter than evergreen woody exotics from the same climates; otherwise they are apt to lose their leaves, and to rot at the points of the shoots. To prevent this, heat should be given in the day time, and air admitted; and whenever any leaf begins to decay, it should be removed. The hardier plants may be placed in the open air during the summer, taking care to remove them during heavy rains, which is apt to destroy their flowers.

The finer and more delicate sorts should, however, be kept in the house, allowing them free air both day and night. In warm and sheltered situations it is usual to plant out some of the hardier species into the open borders, in April and May. These will grow vigorously, and afford a profusion of flowers until the commence-

ment of winter, when the plants may either be protected in their situations from the frost by plenty of litter or mats; or they may be removed into pots, and placed under cover. It is even found that if the plants are taken up, cleared of their stalks and fibrous roots, the wounds made in doing this healed by exposure in a dry place; and afterwards the roots deposited in layers in a mass of sand, and then placed in a cellar, or otherwise excluded from frost, they will retain their vegetative power through the winter, and grow vigorously when replanted in the open air in spring. Or, according to another method, a stock of rooted cuttings may be thickly planted in pots, and preserved in the house during the winter, and in spring planted out separately.

American Aloe* *(agave Americana)*. Natural family *bromeliaceæ; hexandria, monogynia*, of Linnæus. This is a celebrated and splendid plant, a native of South America. It is a succulent plant, without stem, the leaves being radical, spiny, and toothed. The flower rises to several feet in height, bearing a number of large and splendid flowers. There is a variety with striped foliage, and occasionally these stripes are of different shades, of white, yellow, and red. It has been completely acclimated in Sicily, Calabria, Spain, Portugal, and the West India islands, where it grows wild in abundance, forming hedges. It is also much used in France, Germany, and Britain, grown in vases to adorn apartments, or the conservatory. It was at one time a prevailing idea, that this plant only flowered once in a hundred years; this is now found to be a popular error. In cold climates, and with ordinary culture, there are certainly long intervals between the times of its inflorescence; but when it obtains sufficient heat, and receives a culture similar to that of the pine apple, it is found to flower much more frequently. In Jamaica, the leaves have been used as a substitute for soap. For this purpose they are cut off and passed through the rollers of a mill, with their points foremost. The juice which flows out is conducted into wide shallow receivers, through a coarse cloth or strainer, and is then exposed to the sun till the watery part is evaporated, and the remainder is reduced to a thick consistence. It is then made up into balls with wood ash ley; and in this state will lather with salt water as well as with fresh. A soap may also be prepared by pounding the leaves in a wooden mortar, and then expressing the juice, which is then to be evaporated to a proper consistence in the sun, or by boiling. One gallon of juice thus prepared, will yield about one pound of a soft extract. The juice in both these ways, must be carefully strained; and the extract must never be combined with tallow, or other greasy materials. The leaves are also used for scouring pewter, and other kitchen utensils, and floors. The inward spongy substance of the decayed stalk is employed as tinder. The fibres of the leaves, separated by bruising and macerating in water, and afterwards beating them, may be spun into a strong, useful thread. There are several species of the agave, all of which very closely resemble each other.

* See Plate XII.

Adam's Needle *(yucca)*.* Natural family, *liliaceæ; hexandria, monogynia*, of Linnæus. There are several species of this genus, all remarkable for the splendour of their flowers; the most majestic are the *y. gloriosa, superba*, and *augustifolia*. In general appearance, the plants resemble the aloe tribe. The gloriosa, when in blossom, presents a flower stalk from six to eight feet in height, and covered with hundreds of large white depending flowers, which blow in succession, affording one of the most splendid examples of an ornamental plant that can be conceived. They are natives of America, and have been acclimated to this country. They grow slowly, however, in the open air, and do not flower often. They are, however, of easy culture in the conservatory, and are propagated by new shoots, which spring up from the root.

Gloriosa *(Superba* and *Simplex)*. These plants are so named from the splendour of the flower. They belong to the same natural family as the yucca, and are natives of the East Indies. They require great management in order to flower freely. According to Sweet, when the stalks and foliage have decayed in the autumn, and left the tuberous root like a well ripened potato in a dormant state, the pot containing it must be removed from the hot-bed to a dry situation, at some distance from the fire; all the warmth at this time necessary being merely what is sufficient to keep the earth in the pot free from damp, and to prevent the waterings of the house or other moisture, from falling on the earth in the pot; it should be covered by inverting upon it another pot of the same size, or if larger, it will hang over its edges, and more effectually exclude the wet. If the roots are small, two or three may be placed together in the same pot, whilst in their dormant state; but if they are thus shifted, the mould must be well shaken down in the pot, in order to prevent the access of air to them. The old mould in which they grew, must also be used; for fresh earth or sand, would stimulate them to move too early. About the second week in March the roots must be replanted, putting one or two, according to their size, into pots measuring six inches over. The best compost for them is fresh loam, mixed with an equal quantity of peat mould, of good quality. The roots are to be covered about two

* See Plate XII.

inches deep; and care must be taken not to break them, unless nature has shown where it is practicable to divide them easily. The pots, when filled, must be plunged into the bark bed, where the heat should be equal to 95°. At first, water is to be given very sparingly; and though, as they grow, they will require a more liberal supply, yet it is necessary at all times to be very moderate in giving it. The heat must be well kept up, and as the roots extend they must be supported. Under such treatment, a plant has been known to grow ten feet in the course of a season, with numerous blossoming stems upon it. The flowers are at first green; and they afterwards assume those beautiful yellow tints for which they are so much celebrated. The plant is readily propagated by dividing the roots.

STAPELIAS. Natural family *asclepiadeæ; pentandria, digynia*, of Linnæus. This family of

226.

Wart-Flowered Stapelia.

plants grows at the Cape of Good Hope. They have diminutive, succulent stems, without leaves, with proportionally large, curious flowers, whose odour is frequently very disagreeable. Yet, from their singular forms, the plants make a curious variety in the conservatory. There are several genera, and numerous species, almost all natives of Africa. They were first introduced into the gardens at Kew, by Masson, about the end of last century. Some of the species are used as articles of food by the native Hottentots, and by the Dutch settlers at the Cape, in the form of a pickle. They thrive best in a sandy loam, mixed with old lime or brick rubbish. If planted in a richer soil, they will thrive better for a time, and produce larger flowers; but then they are very apt to rot off, particularly if watered too freely. Indeed, they require very little moisture, except when they are in flower, when water may be given more freely. They are readily propagated by cuttings. These should be laid to dry in the stove till they begin to shrivel, and if planted in this state in pots, they will root in a very short time. If planted immediately on separation from the stem, and when full of juice, they are very apt to rot.

MARVEL of PERU *(mirabilis dichotoma*, and *jalapa)*. Natural family *nyctagineæ; pentandria, monogynia*, of Linnæus. This is one of the most fragrant of flowers, and has the singular property of expanding during the night. On these accounts it has received its names; having been first called by Clusius *admirabilis*, and by Van Royen, *nyctago*, or night-blowing. *M. dichotoma* is called the four o'clock flower in the West Indies, from the flowers opening regularly at that time of the afternoon. The common marvel, *(m. jalapa)*, of which there are several varieties, will grow in this country in warm sheltered borders, and forms a very pleasing and ornamental flower. In order to have it in perfection, it should be sown in pots in the greenhouse, and then planted out into a sunny sheltered border. The roots are large and tuberous, and if taken up and treated in a similar way as directed for dahlias, and planted out in summer, they will flower perennially. These roots, when washed and dried, are reduced into powder, forming a substance similar to jalap, and possessing similar purgative properties.

THE RAFFLESIA ARNOLDI. This flower, of which a figure is given at page 170, is one of the most extraordinary productions of the vegetable kingdom. It is a parasitic plant, a native of the island of Sumatra, and was discovered there in the year 1818, by the late Dr Arnold. He found it in a jungle or thicket, growing close to the ground, underneath the bushes, and attached to the roots of a species of *cissus*. The plant consists of a flower only, having neither leaves, branches, or roots. This flower however, is of gigantic size, measuring a yard across. The petals, which are roundish, were twelve inches from the base to the margins, and at their insertions about a foot separate from each other.

These petals are from a quarter to three-fourths of an inch thick, and the nectarium was calculated to be of such a capacity as to hold twelve pints. It appears to take its origin in some crack or hollow of the stem, and soon shows itself in the form of a round knob, which when cut through exhibits the infant flower enveloped in numerous bracteal sheaths, which successively open and wither away as the flower enlarges. A singular change takes place in the vessels of the root, or stem of the tree on which it grows, their ramifications are multiplied, and they take a direction so as to unite with, and accommodate themselves to the base of the parasite, to which they convey nourishment. The general appearance of the flower resembles the stapelias, and like them its smell is fœtid. It is diœcious and supposed by Brown to belong to the natural order *asarinæ*. There have since been discovered other species of much smaller dimensions.

VENUS FLY TRAP. *Dionea muscipula; decandria, monogynia*, of Linnæus. This is a plant

more curious than beautiful, a native of Carolina. The root is scaly, nearly resembling a bulb, and not prolific in fibres. The leaves have the petiole winged, like the orange; and the extreme part, which may be called the proper leaf, is formed into two halves, which move on a central hinge,

227.

Venus Fly Trap.

and fold up and contract on the slightest contact with any substance. The edges are beset with spines, and the surface is covered with a glutinous mucilage. The flowers grow in a corymb, resembling an umbel. When flies alight on the extremities of the leaves, the contact of their feet produces sufficient irritation to make the two halves contract suddenly and firmly, by which the fly is crushed and pressed to the glutinous sides, to which it is fixed until it dies. Linnæus affirms, that when the entrapped insect ceases to struggle, and is quiet, the leaf opens and permits it to escape; while Ellis, on the other hand, says, that the lobes never open again so long as the animal continues there. He thinks it probable that a sweet liquor discharged by the red glands, tempts the insect to its destruction; and adds, that if a straw or pin be introduced between the lobes, they will grasp it as fast as if it were an insect.

This plant is rather difficult to raise. According to Sweet, it thrives best in a pot of sphagnum, with a little mould at the bottom of the pot, and placed in a pan of water. In all cases, it is necessary that the plants be supplied with fresh cool air.

Water Lily. *Nymphea; polyandria, monogynia,* of Linnæus. This genus contains several beautiful species, which are aquatic plants, growing in ponds and slow running streams. The common water lily *(n. alba)*, has broad showy leaves, which float on the surface of the water; and a large white flower, with numerous petals, so as almost to appear double. It rises out of the water and expands about seven o'clock in the morning, and closes again about four in the afternoon, reposing on the surface till it again expands in the morning. The roots have an astringent, bitter taste, and are used in the highlands of Scotland and Ireland to dye cloth a dark brown or purple.

The *lotus* resembles the common water lily, only the leaves are toothed at the edges. It is a native of the hottest parts of India, Africa, and America; and is abundant in the ponds and rivers of Jamaica. The banks of the Nile are famous for this plant, which grows during the time the country is under the annual floods of the river.

The *Common Yellow Nuphar (n. lutea)*, is another aquatic plant, which has a very beautiful appearance in artificial ponds.

All these plants are easily reared either in ponds or in pots of water, with a few inches of soil in the bottom. They are propagated by dividing the roots, and by offsets from the bulbous species.

The Sacred Bean of India is supposed to be the *nelumbium speciosum*, a large petalled and splendid aquatic plant.* It is a native of both the East and West Indies, China, Japan, and Persia, and Asiatic Russia. According to Thumberg, it is esteemed a sacred plant in Japan, and pleasing to their deities; the images of their idols being often represented as sitting on its large leaves. The long stalks are used by the natives as an article of diet. Loureiro mentions that it abounds in muddy marshes in India and China, and is cultivated in large handsome pots in the gardens and houses of the mandarins; that there is a variety with the flower of a pure white, and another with a very beautiful luxuriant flower, having about one hundred large petals, white or rose-coloured. Both root and seeds are esculent, sapid, and wholesome. The Chinese call it *lien-wha*, and the seeds and slices of the hairy root, with the kernels of apricots and walnuts, and alternate layers of ice, were frequently presented to the British Ambassador and his suite at breakfasts given by some of the principal mandarins. The Chinese have always held this plant in such high value, that at length they regarded it as sacred. That character, however, has not limited it to merely ornamental purposes, for the roots are not only served up in summer with ice, but they are also laid up in salt and vinegar for the winter. The seeds are somewhat of the size and form of an acorn, and of a taste more delicate than that of almonds. The ponds are generally covered with it, and exhibit a very beautiful appearance when it is in flower; and the flowers are no less fragrant than handsome. Sir George Staunton remarks, that the leaf, besides its common uses, has, from its structure, growing entirely round the stalk, the advantage of defending the flower

* Shortly alluded to, p. 270.

and fruit arising from its centre from contact with the water which might injure them. He also remarks, that the stem never fails to ascend in the water from whatever depth, unless in case of a sudden inundation, until it attains the surface, where its leaf expands, rests, and swims upon it, and sometimes rises above it. This plant bears the rigorous cold of the Pekin winter, though it is reared with difficulty in European stoves. It often grows spontaneously in China, and is propagated in the open air with ease, both from seed, and by the root. The Chinese have many varieties of it. It is said that from the root of this plant the ancient Egyptians prepared their *colocasia*, but the nelumbo is no longer found in that country, from which some naturalists infer that it never was indigenous there, but cultivated by the inhabitants with extreme care. The ancient Romans made repeated efforts to raise it among them from seeds brought out of Egypt; and the modern attempts to cultivate it in Europe, though with the assistance of artificial heat, seldom have succeeded. In this country it is generally grown in large tubs, with a few inches depth of water over the surface of the mould.

CHAP. LIV.

ORNAMENTAL SHRUBS, HEATHS, &c.

The varieties of shrubs and small trees suited as ornaments for the garden, either from the beauty of the foliage, or the size and splendour of the flowers, are nearly as numerous as those of herbaceous plants. We proceed to describe some of the most remarkable of these.

The Rose. We have already alluded to the rose as a medicinal plant, (p. 536), and are now to consider the several species and varieties, as the most agreeable ornaments of the flower garden. From the earliest times the rose has been celebrated as the chief of flowers, and has been familiar among all the civilized nations of Europe and Asia. It is to be seen in all its varieties, from the cottage garden up to the precincts of the palace. The name is derived from the Latin word signifying red. There are various species, although botanists are not agreed as to their number. Some have, however, supposed all the European species to have originated from one source, while others divide them into numerous species and varieties. Lindley enumerates not less than one hundred species and varieties; and Miss Lawrence has published ninety plates of roses, figured from natural specimens. Several splendid works have also been published in France and Italy descriptive of this genus. Lists of from three to five hundred sorts are to be found in some of these works; indeed, new varieties are raised both in France and Britain every year. The usual colours are scarlet, pink, variegated, white, purple, and yellow.

The most common species are the Chinese, or monthly rose, the cinnamon, the damask, the evergreen, or Ayrshire rose, the blush, the white, the moss, the dog rose, and the common cabbage rose. The earliest flowering rose is the monthly, which in mild seasons, and under the shelter of a wall, will sometimes flower in the beginning of April; the next is the cinnamon, which flowers in May; the damask in the end of May or first of June; the blush, York and Lancaster, Provence and Dutch hundred-leaved, in June, July, and August. The Virginia and musk roses are the latest European sorts; they flower in September, and in shaded situations, will sometimes continue in bloom till the middle of October. But the earliest rose is also the latest, and generally continues flowering till interrupted by frost.

The rose may be propagated by seed, by layers, or cuttings, and by budding. Most of the species, in their state of nature, are found growing on a sandy, and rather poor soil, except those which are natives of woods, where the soil is richer, and more moist. But for cultivated roses, especially the double flowering kinds, a rich loamy soil inclining to clay is the best. They also require to be liberally supplied with water. All the varieties of the cultivated rose are double or semi-double, that is, their organs of fructification are converted into additional petals, or the petals are otherwise greatly multiplied. The vicinity of large towns, where the air is confined and vitiated, is very inimical to the rose; indeed, no species will thrive in such situations.

In raising from seed, the hips are to be gathered in October or November, when they are ripe. These may be preserved whole during the winter in a dry situation; or the seeds may be rubbed out immediately on gathering the hips. The seeds require to remain one year in the soil before they vegetate; so that if they are sown in February or March, they will come up in the following spring. The seed should be put into a soft moist soil, composed of equal parts of sand and vegetable mould, in a shady situation, and covered with about half an inch of soil. They should afterwards receive a regular supply of water till the plants have come up, and attained a few inches in height. Early in the second spring they may be transplanted in rows, a foot apart every way; and a year afterwards, again transplanted to a greater distance asunder. Hence they may remain till they flower, which varies in different sorts from the third to the fifth year; but most commonly during the fourth summer.

To increase the chance of new varieties, various

species should be congregated together, so that the seed-bearing plants may have a chance of crossing with different sorts. Or the method of Mr Knight, employed in other flowers, might be practised; that of extracting the stamens from the flower, and dusting the stigma with pollen from the anthers of other plants.

The common mode of propagating by layers, is to lay down the young shoots of the preceding summer late in autumn, or early in the succeeding spring, when rooted plants will be formed by the next autumn. It is found, however, that if the same shoots are laid down when the plant is beginning to flower in July, they will, with a few exceptions, produce roots, and be fit to remove the same autumn, by which a whole year is gained. It is even found that the tip of the fixed layer itself may, in some kinds of rose, be again layed; and this secondary layer will have roots formed to it in the same season. Such sorts as do not root in one year, as the moss rose, and some others, must be left on the stools till the second autumn. But layers made when the shoots are in a growing state, and furnished with healthy leaves, root much more freely than shoots with ripe wood. After the plants are removed from the stools, they are planted in nursery rows; and in a year, the blossom buds having been carefully pinched off from the first laying down, they will be fit for removal to their final destination. The stools are then to be pruned, and the soil dug and manured. An improved method of laying roses is suggested in the Gardener's Magazine. A slit is to be made with a knife up the centre of the inlaid portion of the wood of the layer, and a small piece of stone or wood is introduced to keep the slit open. In this way the rooting is greatly facilitated.

Many of the common kinds of roses may be rapidly multiplied by cutting off the suckers which spring from the roots, and planting them out at once: or cuttings of the young wood may be taken and put into the ground; and in some species, as the Indian and China roses, they will strike freely.

Budding is resorted to chiefly for the rarer sorts, and such as are of difficult propagation by layers; for it is found that plants so procured, even though on hardy enough stocks, are less durable than those raised otherwise. This process has of late become very common in the formation of standard stems, with varieties of roses growing from them. This is a modern invention, supposed to have originated in Holland, from thence copied in Paris; and about the beginning of the last century adopted in Britain. These may be rendered highly ornamental to parterres and borders. The stocks are formed of the tree rose, the dog rose, or any other strong and tall-stemmed species. These stocks may be from three to seven feet from the ground. One remarkable stock in the Paris garden is fifteen feet high; and there are others of similar dimensions at Malmaison, and the grand Trianon.* The stock is procured from a wood or copse, and may be budded the same season in which it is transplanted, or in the following spring or summer.

Generally, two buds are inserted on the opposite sides of the stock; but sometimes three, four, or a dozen, in alternate positions, on the upper six or twelve inches of the stem. Every stock is supported by a rod, which should reach a foot or eighteen inches higher than the situation of the bud; to this rod the stock is tied, and afterwards the shoots from the inserted bud, which would otherwise be liable to be injured by high winds. The buds inserted may be of all the different varieties; they will grow out freely, and flower, and thus afford a rare and interesting assemblage.

The Parisian gardener having the advantage of finer stocks, and a better climate than can be obtained in England, produces superior and cheaper plants, which are exported along with other roses in great profusion into this country.

In rosaries, the usual practice is to introduce but one plant of each sort; and the varieties nearest akin to each other are grouped together, by which their distinctions are made more conspicuous. Sometimes compartments are formed of particular species, as the Scotch, Chinese, yellow rose, or others, which has a pleasing effect. An elevated rock work in the centre, bound with creeping roses, also forms a pleasing variety; or, hedges of roses may be formed with standard roses, interspersed at regular distances.

To produce vigorous and beautiful flowers, some attention is necessary in the treatment of roses. The old wood should be annually pruned off, and the young shoots thinned and shortened, according to their strength, or according as number or magnitude of flowers is wanted. Those plants which throw up numerous suckers, require to be taken up every three or four years, the roots reduced, and the offspring planted for new plants; at the same time, that part of the old soil about the roots is replaced with fresh mould. When pruning is performed in early spring or winter, the points of the shoots of the more delicate sorts are apt to die. This process then, should be practised on such sorts in the month of June. The most usual time of pruning and dressing, is immediately after the blow is over. When very large roses are wanted, all the buds but that on the extreme point of each shoot, should be pinched off as soon as they make their appearance; while at same time a liberal supply of water is given.

* Loudon.

The rose is peculiarly liable to the attacks of the plant louse *(aphis rosæ)*, a small green insect, which burrows in the leaves, and extracts the juices of the plant. Sometimes these exist in such myriads, as to completely destroy the leaves. They commence with the first buds in February, and many generations are successively propagated during the season. They are very difficult to eradicate. Hand picking early in spring, and washing the plants with lime water and tobacco juice, are recommended. Another insect, the *cynips rosæ*, attacks the bark of many roses, especially the sweet brier and Scotch rose. These insects, by burrowing in the bark, cause excrescences, or rose galls, similar to those found on the oak. These were formerly employed in medicine, under the name of *bedeguar*.

All roses are not odorous. The most fragrant are the common cabbage rose, the white rose, and musk rose. The mode of extracting the oil or attar of roses, has already been mentioned, (p. 537). The sweet brier rose is remarkable for the agreeable fragrance of its leaves, which becomes very perceptible after a shower.

The Myrtle *(myrtus)*. Natural family *myrtaceæ; icosandria, monogynia*, of Linnæus. This is a plant celebrated and esteemed since the time of the ancient Greeks, who called it *murtos*, from the perfume of its leaves. The common myrtle *(m. communis)*, is a native of the South of Europe, and has been a popular shrub in English gardens from a remote period; for even before the invention of green-houses, it appears to have been preserved throughout our winters by covering it up, or removing it within the shelter of a house. It is an elegant evergreen shrub, with handsome, deep green, shining leaves, which, on being pressed by the fingers, emit an aromatic odour. The flower is white, small, and handsome. The ancients dedicated the myrtle to Venus, either on account of its elegance and fragrance, or that it grew in situations near the sea, the birth place of that goddess. The bloodless victors at the Olympic games were crowned with wreathes of myrtle; and it was the symbol of authority for magistrates at Athens. Both the branches and berries were infused in wine; and the latter were employed in the cookery of the ancients. It was also a medicinal plant, although disused in modern practice.

There are several varieties of the common myrtle; as, the broad-leaved, box-leaved, Italian, Portugal, orange-leaved, rosemary-leaved.

It is of easy culture in the green-house, or even in common apartments, and is readily propagated by slips. In warm sheltered borders, it will also thrive in the open air, but requires protection in severe winters.

There are several other species, natives of the West Indies and China.

The Sumach-leaved (m. coriacea), a native of Hispaniola, and sometimes called the wild cinnamon, is a very elegant tree, with a handsome ash-coloured straight trunk, and pyramidal head. It is of slow growth and flowers late, twice a year. The bark has an aromatic quality, and in old trees it becomes white, and separating from the trunk hangs down in shreds. The timber is of a red colour, very hard and fit for mill-work. The berries, which are about the size of peas, and possessed of a very agreeable aromatic taste and odour, are used for culinary purposes.

Jasmine. Natural family *jasmineæ; diandria, monogynia*, of Linnæus. This is a genus of pretty shrubs, famous for the odour of the flower. Several species are natives of India, one or two of the south of Europe. The common jasmine has been from remotest times a great favourite in gardens, the modest white starlike flower contrasting well with the deep green of the stem and leaves. The flowers are highly odorous, and yield by distillation an essential oil, having the same odour. It is not known from what country it originally came, but according to Gerarde, as far back as 1597 it was in common use as a wall-shrub, and for covering arbours.

The *Single Arabian (j. sambac)*, is highly prized in India, where it is a native, for the exquisite fragrance of the flowers. It grew in Hampton Court gardens towards the end of the seventeenth century, but was lost there, and was known in Europe only in the garden of the Grand Duke of Tuscany, at Pisa, where, according to Evelyn, the plant was placed under guard that no cuttings might be purloined. In 1730, a plant was sent to Miller, and it is now a common greenhouse shrub in this country. The Italian jasmine is also very odoriferous, and plants of it are obtained from Genoa along with orange trees. The Hairy Indian *(j. hirsutum)*, attains the height of a tall tree, whose sweet-smelling flowers open during the night and fade at sunrise. All the species are easily reared and propagated from cuttings, which root readily under a hand-glass. The best soil is a light loam with an admixture of peat.

Privet *(ligustrum)*. Natural family *oleinæ; diandria, monogynia*, of Linnæus. This is a well known garden hedge plant, for which purpose it is well suited from its pliancy under the shears. In its cultivated state it becomes an evergreen, although when found growing wild in woods and hedges, it is generally deciduous. Like most plants which have been long cultivated, it varies in the form of its leaves, flowers, and fruit. The berries remain on the branches during winter, forming elegant purple clusters, and are not eaten by birds generally, unless in very severe winters when nothing else can be procured. The privet is a very hardy plant, and will thrive in almost any soil or situation—in

the smoke of cities, in the shade, or under the drip of trees; although in order that it may produce good flowers, it requires an open situation. It is browsed on by cows, sheep, and goats, but horses refuse to eat it. In the varieties, the leaves sometimes grow by threes, and are enlarged at the base, and variegated. Sometimes there are three or four stamens instead of the natural number, which is two. The colour of the berries also varies from purple or black to white and yellow. A rose-coloured dye is prepared from the berries, which with alum imparts to wool or silk a durable green. Two species of moths, the privet hawkmoth *(sphinx ligustri,)* and the *phalæna syringaria*, feed on it in their larva state, and it is said that the common blistering fly also frequents this shrub. The Chinese privet or wax-tree produces from its berries a kind of vegetable wax, somewhat resembling that from the *myrica cerifera*.

The Berberry. *Berberis vulgaris; Hexandria, monogynia.* This is also a common and useful shrub, and when covered with blossom in spring or fruit in autumn, forms no mean ornament to the garden or lawn. The leaves are ovate, of a light yellow, or bluish green, and when chewed afford a pleasing acid taste. The odour of the flowers is too strong when near, but pleasant at a little distance. The berries are in one variety purple, in another white. They are powerfully acid, and are employed either as a pickle for garnishing dishes, or boiled with sugar form a pleasant jelly, which is used as a sweetmeat, or occasionally in medicine, as a cooling astringent in febrile diseases. The roots and bark are employed as a dye, and impart a yellow colour to linen or leather. Sheep, goats, and cattle, feed on its leaves, and insects of various kinds frequent the flowers. One of these, the *œcidium berberidis*, its particular inhabitant, is supposed by some to carry from this flower a peculiar dust, which falling on growing corn gives rise to rust. This has been, however, doubted by others, and the rust assigned to the growth of a minute fungus. Linnæus and Smith have remarked, that the anthers of the berberry are so sensitive as to explode when touched by the feet of the common bee, by which the pollen is scattered on the stigma. There are several other species besides the common berberry, all of which are very ornamental shrubs, such as the clustered, the Nepal, the holly-leaved.

Clematis, or Virgin's Bower. Natural family, *ranunculaceæ; polyandria, polygynia*, of Linnæus. This is a very useful and ornamental genus of climbing shrubs, of rapid growth, free flowerers, and some of them highly odoriferous. The favourite species are the large flowered *florida*, the purple *viticella*, the round leaved *flammula*, and the American *verticillaris*. They are all hardy plants, and will grow freely in any common soil, and are readily increased by layers or young cuttings, which if planted under a common hand glass will root freely. They may also be raised from seed, which is produced and ripened in great abundance. These should be sown in wide-mouthed pots, placed in a shady situation, and after the plants have come up, they are to be planted out into the places where they are required to grow.

Passion Flower. *Passiflora; monadelphia, pentandria*, of Linnæus. This genus has obtained its name from a fanciful idea, that the appendages of the flower represent the passion of Jesus Christ.

They are all climbing plants, partly herbaceous, and partly shrubby; natives of South America, the West India islands, and China. There are many species; some are odoriferous, and others bear fruits, which are edible, though not of very rich flavour. The leaves are of various forms, ovate, round, elliptical, lobed, sub-cordate; some are entire, and others serrated at the margins. The flowers are very beautiful, varying from red, to white, blue, and purple.

The *Common Passion Flower (p. cerulea)*, is the tallest and most woody of this family. The stem attaining almost the thickness of a man's arm, from which shoots will spring out to the length of fifteen feet in one season. The leaves are palmate, and five lobed, with smooth edges, and have a very elegant appearance. The flowers are blue outside, and purple and white within. They have a faint odour, and are very evanescent, continuing but for a day. The fruit is egg-shaped, and encloses a sweetish, disagreeable

228.

Passion Flower.

pulp, in the centre of which are the seeds, which are black coloured.

Several of the varieties of this species are very beautiful, as Milne's hybrid, *(p. cerulea racemosa)*; the narrow-leaved *(angustifolia)*, and the

Chinese. These are all hardy green-house plants, and thrive well in a mixture of loam and light rich earth, or peat; and may be propagated by seeds, or very young cuttings, put into close moist earth.

The *Sweet Calabash, (p. maliformis)*, a native of the West Indies; produces large flowers, of a red, white, and blue colour, but of short duration. The fruit is round, the size of a large apple, with a sweetish pulp, in which are lodged many oblong, black seeds. This fruit is used as a dessert.

The *Granadilla Vine (p. quadrangularis)*, has a square stalk, and leaves five to six inches in length. The flowers are red within, and white outside. They are odoriferous, and generally the plant is covered with fruit and flowers at the same time. The fruit is very large, being an oblong, of about six inches in diameter from the stalk to the eye, and fifteen inches in circumference. Externally, it is greenish yellow; when ripe, soft and leathery to the touch, and quite smooth. The rind is very thick, the pulp is of a purple colour, and is eaten with wine and sugar. It has a sweet, slightly acid flavour, and is very grateful to the taste.

All these species will fruit in large pots, in hot-houses in this country. The roots are planted in a compost of very old tan and rich dung, in which they will strike freely. They require only a temperate heat of about 70°. As they grow, the very strong shoots should be cut off, as these do not bear so well as those which are less vigorous.

Honey-suckle, or Wood-bine, *(caprifolium.) Pentandria, monogynia*, of Linnæus. This is one of the most beautiful of our native climbing shrubs, both as respects the foliage, and the rich and odoriferous flowers. The honey-suckle is well adopted for arbors, walls, gateways, and indeed any situation in the shrubbery. In the twisting of its stalk it follows the course of the sun, which is the case with most British climbing plants. It grows luxuriantly, can be trained in any direction, and bears pruning well. Professor Martyn observes that those plants which in a state of nature cannot ascend without the assistance of others, are often liable to lose large branches; they have therefore a proportionate vigour of growth to restore accidental damages. Against a wall the climbing kinds are very liable to attacks of *aphides;* and the caterpillar of *phalona tortrix*, and the hawk-moths, according to Withering, extract the honey from the very bottom of the tubular flowers with their long tongues. The common woodbine, *c. periclymenum*, of which there are two or three cultivated varieties, grows abundantly in woods and coppices in Britain; there are other species, natives of America, China, and the south of Europe.

The seeds of honey-suckle should be sown the autumn after they are ripe, otherwise they will not come up the first year.

The plant may also be propagated by cuttings.

Lilac *(syringia)*. Natural family *oleinæ, decandria, monogynia*, of Linnæus. The lilac is a beautiful and fragrant flowered shrub, a native of Persia, though it is now completely acclimated to this country, and thrives well in the open air.

Of the common lilac, *s. vulgaris*, there are two usual varieties, a purple and a white. There is also the Chinese and Persian lilac. All the sorts are readily propagated by suckers from the roots, which grow up in abundance. The common lilac appears to have been introduced into Britain before or during the reign of Henry VIII., for in the inventory taken by order of Cromwell, of the articles in the gardens of the palace of Norwich, are numbered "six lilac trees, which bear no fruit but only a pleasant smell."

Camellia. *Monadelphia, polyandria*, of Linnæus. The natural family *camellia* includes the tea plant already described; and several species of beautiful flowering shrubs, all natives of China.

The *Camellia Japonica*, as it grows in the woods and gardens of Japan and China, is a lofty tree, of beautiful proportions, and clothed with a deep green shining foliage, with large elegant flowers, either single or double, and of a red or pure white colour. It is much cultivated among the Chinese and Japanese; and appears a great favourite, as it is frequently figured in their plantations along with other two favourite plants, *hibiscus* and *crysanthemum*. There are numerous varieties of *c. Japonica* in China, the greater part of which have found their way to this country; while other new varieties have been found here. The double-white, double striped, and double-waratah, the last so called from the central petals resembling those of the waratah plant of New Holland, are considered the finest varieties, and are also free growers and flowerers; the pæony-flowered and fringed are also much admired.

The *Oil-bearing Camellia (c. oleifera)*, is cultivated for its seeds, from which an oil is expressed, and which is very generally used by the Chinese in their cookery. It thrives best in a red sandy soil, and attains a height of six to eight feet, producing a profusion of white blossoms and seeds. These seeds, and indeed the seeds of all the other species, when reduced to a coarse powder, strained in bags, and then subjected to pressure, yield an oil.

The camellia received its name from a Jesuit, named Camellus, the author of a work on botany.

The single red camellia is propagated by cuttings, layers, and seeds. It forms suitable stocks,

on which the other sorts are either inarched, or budded and engrafted. The cuttings to be selected are the ripened shoots of the preceding summer; these are taken off in August, cutting them smoothly at a joint or bud; two or three of the lower leaves are taken off, and the cuttings then planted firmly in the soil with a dibble. The soil used by some is peat earth and sand; while others use a rich loam, with a little sand, peat earth, and cow dung. The pans containing the plants are to be kept in a pit or cold frame, without being covered with glasses, but they are to be shaded during powerful sunshine; and in the following spring, such as are struck will begin to push, when they are to be placed in a gentle heat. In the following September or October, the rooted plants will be fit to pot off; and in the second or third spring they may be used as stocks. Inarching or ingrafting is performed early in spring, when the plants begin to grow. Having accomplished this process, care is to be taken to fix the pot containing the stock, so as that it may not be disturbed during the connection of the scion with the parent plant The grafting being clayed over, is then covered with moss to prevent its cracking. When independent grafting is resorted to, the mode called side grafting is generally used, as in the case of orange trees; but the operation of *tongueing* is generally omitted, as tending to weaken the stock. A few seeds are sometimes obtained from the single red, and semi-double camellias, and from the single *waratah.* These require two years to come up, but make the best stocks of any.

The tea camellias are generally propagated by layers, but will also succeed by cuttings.

In order to raise and exhibit camellias to the best advantage, they should have a separate house assigned them. This house should be of ample height, as the plants never look so well as when six or eight feet high, trained in a conical form, and clothed with branches from the root upwards. The plants should be raised near to the glass by means of a stage, which should be so contrived, that as they advance in height it may be lowered in proportion. The best and most even crown glass should be employed, because it is found from experience that the least inequality of surface, or thickness of material, so concentrates the sun's rays as to burn, or produce blotches on the leaves of the plants.* Every cultivator must have observed, that the leathery shining leaves of the orange or myrtle tribes, are more or less obnoxious to this solar injury; but the leaves of the camellia are particularly so. Some recommend a roof that will not admit much light; others the substitution of green glass, or of glass in part only; while others prefer as much glass and light as possible, taking care to shelter from the excessive rays of the sun. Much care is necessary to raise these plants well. The roots are apt to get matted, and by the space they occupy, so to compress the ball of mould, as after a time to render it impervious to water. Hence attention is requisite to see that the water poured into the pot moistens all the mould thoroughly. To prevent this, the roots should be examined and pruned once every year. A liberal supply of water is always necessary, but especially when the plants are in flower. A degree of heat above that given to ordinary greenhouse plants is also requisite, particularly in November and December, when the blossoms are about to expand. In order to form handsome plants, they should be trained with single stems to rods, and pruned, so as to make them throw out side branches from every part of the stem; and to encourage them, the plants should not be placed too close to each other on the stage. In summer, they may be either exposed to the open air in a sheltered open situation, or the glass roof of the house may be taken off. The hardier sorts, such as the double red, blush, and pæony-flowered, do very well to be planted in the bed or border of a conservatory, provided the roof or the entire frame-work can be removed in summer, so as to admit the full influence of the air. If this is not practicable, they are better in portable pots or boxes. The single and double red camellia will stand the open air when trained against a south wall, and protected by mats in winter. According to Henderson's directions, the best time for shifting camellias is the month of February, or the first of March. After this process, they are to be put into a vinery or hot-house, where there is a little heat, or in the warmest part of the greenhouse. In this situation, they will soon begin to make new wood; and they are to be liberally supplied with water, and may remain in this situation till they have formed their flower buds at the extremity and sides of the young growth, when a few of them may be removed to a cold place, and into the shade during strong sunshine. In a few weeks afterwards, others may be removed to a cold place; and this is to be repeated as often as required, in order to have a regular succession of flowering plants. Those that are wanted to flower early, may remain in the warm house till they are beginning to flower, when they should be removed to a cold place, such as the back of the greenhouse, where, if they have plenty of light, they will continue long in blossom. A camellia cannot stand much heat when in flower; indeed, they are seldom disclosed well when in heat, and they very quickly fall off. Those that are kept in the hothouse or vinery during the whole summer, will flower in the beginning or middle of October; and a large

* London's Encyclopedia of Gardening.

plant, having from fifty to one hundred flower buds, will continue in blow till the month of January. Those that are removed early, will now be in flower in January, and ready to succeed the others. Such as have ceased flowering, are immediately to be removed to the hothouse, where they will begin to make new wood, and will be ready to come into succession next season. By thus attending to shift the plants from a warm to a cold situation, a regular succession of flowers may be obtained from October to the following July. The winter flowers are, however, superior and longer lived than those of summer. They flower best when kept in rather small pots or tubs. The mould should be kept constantly moist with water, and in the summer months the leaves may also be occasionally sprinkled with this fluid. "There are," adds Mr Henderson, "several large camellias at Woodhall that have not been shifted these five years, and they are still in high health, having always produced above a hundred fine large flowers every year. Six years ago I shifted a single camellia from a twelve inch pot into a tub seventeen inches wide by seventeen inches deep, and grafted it with two different sorts of double red, one double striped, and one double white. It is still in the same tub, and all the four sorts in high health. I have had all the four sorts in flower at once on it, producing a fine contrast of colours. The plant is large and handsome, being eight feet six inches high, and six feet nine inches wide. There is another plant here twelve feet high, having upon it all the sorts I possess. They were only grafted last summer, and a number of the sorts are showing flowers. Grafts of all of them have been taken, and are growing well."*

Japonica *(aucuba japonica)*. Natural family *lorantheæ ; monœcia, tetrandria*, of Linnæus. This is a well known evergreen shrub, a native of Japan. The leaves are similar to those of the laurel, only they are thickly mottled with yellowish spots. Female flowers only have been produced in this country, but in its native climate it bears fruit like the laurel berry, a red oblong drupe, with a sweetish pulp, and a kernal with a bitter taste. It is of very easy culture, and flourishes in the open air in this country, enduring our severe winters.

Laurestinus *(viburnum)*. *Pentandria, trigynia*, of Linnæus. This is a genus of evergreen garden shrubs of considerable beauty, of which there are several well known species. The small dwarf, *v. tinus*, is a highly ornamental shrub. The leaves are ovate, oblong, shining; the flowers white, numerous, and showy. The gueldor rose, *v. opolus*, has a large bunch of white flowers similar to those of the hydrangea, and like them abortive. Some of the species are natives of Europe, and others of America. They are of easy culture, and thrive in the open air in our climate.

* Caledon Mem. Vol. III.

Sensitive Plant *(Mimosa.)* Natural family *leguminosæ; polyandria, monœcia*, of Linnæus. This is a family of beautiful and delicate shrubs, with small pinnatifid leaves, natives of Brazil and the West India islands.

Several of the species, especially *m. sensitiva* and *m. pudica*, are remarkable for possessing that

229.

M. Sensitiva *M. Pudica.*

Sensitive Plants.

degree of irritability, as to shrink and contract their leaves on being touched. The leaves also fold up close to each other on the approach of night, and expand during the day and sunshine. The cause of this motion has given rise to much discussion among botanists. We have already alluded to this subject, and shall here give a summary of the opinions of Dutrochet, as drawn up by Professor Lindley. M. Dutrochet states that, having ascertained hot nitric acid to possess the property of separating and reducing to its simplest form the whole mass of vegetable tissue, and that the action of the same acid produced other effects equally advantageous for the examination of the most obscure parts of vegetable structure, he was induced to give his attention to that of the *mimosa pudica*, in the hope of gaining some evidence respecting the cause to which its sensibility is to be ascribed. Beginning with the pith, he observed a considerable number of minute globules of a greenish colour intermingled among the cells, and adhering to them in an irregular manner. After attempting to show the probability of these globules having deceived M. Mirbel in various points of his Analysis of Vegetation, and especially in regard to the pores which that botanist supposes to exist in the cellular tissue of plants, Dutrochet proceeds to remark, that the application of hot nitric acid to these globules renders them perfectly opaque. Whence he concludes, that they are in fact minute cells, filled with a particular fluid, which is subject to become concrete by the application of acids. Now, it is known that such fluids as are thus altered by

acids, are usually dissolved and liquified again by the application of alkalies. A few drops, therefore, of a solution of hydrate of potash were suffered to fall upon a portion of the pith on which nitric acid had been acting, and the mixture was exposed to the heat of a lamp. Being examined after a few minutes, the globules were found to have resumed their natural appearance. This curious fact indicated, in the opinion of Dutrochet, a strong and unexpected point of analogy between plants and animals. According to the microscopical researches of some modern observers, it has been ascertained that all the organs of animals are composed of a conglomeration of minute corpuscles similar to those just described; the corpuscles which constitute the muscular are soluble in acids, but those which compose the nervous system, are insoluble in the same acids, and only soluble in alkalies. Now, as the chemical properties and the external appearance among the cellular tissue of plants, and constituting the nervous system of animals, are the same, the author is induced to infer that the spherical particles of plants are in fact the scattered elements of the nervous system. This hypothesis receives additional strength from the great similarity which exists between the medullary substance of the brain of *mollusca gasteropoda*, the snail for instance, and the cellular medullary tissue of plants. In pursuit of this idea, Dutrochet made a variety of experiments upon the sensitive plant, the results of which seem to be these. "The principal point of locomotion, or of *mobility*, exists in the little swelling which is situated at the base of the common and partial petioles of the leaves. This swelling is composed of a very delicate cellular tissue, in which is found an immense number of nervous corpuscles; the axis of the swelling is formed of a little fascicle of tubular vessels. It was ascertained by some delicate experiments, that the power of movement, or of contraction and expansion, exists in the parynchema and cellular tissue of the swelling, and that the central fibres have no specific action connected with its motion. It also appeared that the energies of this nervous power of the leaf depended wholly upon an abundance of sap, and that a diminution of that fluid occasioned an extreme diminution of the sensibility of the leaves. Prosecuting his remarks yet further, the author ascertained that in the motion of the sensitive plant two distinct actions take place; the one of locomotion, which is the consequence of direct violence offered to the leaves, and which occurs in the swellings already spoken of; the other of nervimotion, which depends upon some stimulus applied to the surface of the leaflets, unaccompanied by actual violence, such as the solar rays concentrated in the focus of a lens. As in all cases the bending or folding of the leaves evidently takes place from one leaf to another with perfect continuity, it may be safely inferred that the invisible nervous action takes place in a direct line from the point of original irritation, and that the cause by which this action of nervimotion is produced must be some internal uninterrupted agency. This was, after much curious investigation, determined by the author to exist neither in the pith, nor in the bark, nor even in the cellular tissue filled with nervous corpuscles, and on which he supposes the locomotion of the swelling at the base of the petioles to depend. It is in the ligneous part of the central system, in certain tubes supplied with nervous corpuscles, and serving for the transmission of the sap, that Dutrochet believes he has found the true seat of nervimotion, which he attributes to the agency of the sap alone; while he considers the power of locomotion to depend upon its nervous corpuscles alone."

The sensitive plants are easily reared and propagated; some of the species ripen seed, and others may be increased by cuttings from the points of the young shoots.

Rhododendron. Natural family *rhoduraceæ; decandria, monogynia*, of Linnæus. This is a genus of highly prized evergreen shrubs, which, in addition to the beauty of the foliage, bear large and showy flowers. The name is derived from the Greek, *rodon*, a rose; and *dendron*, a tree. There are several species, chiefly natives of the northern parts of Europe, and North America.

The rusty-leaved *(ferrugineum)*, and hairy-leaved *(hirsutum)*, grow wild in great abundance on the mountains of Switzerland, Austria, Savoy, Piedmont, and Dauphiny. They are found growing at the greatest elevation at which trees will vegetate on those alpine ranges; they afford fuel to the shepherds; grouse are said to feed on them; the white hares sometimes gnaw the bark in winter; but in general, animals do not seem to relish them, probably from their containing deleterious juices. The galls of a small cynips, are found frequently on them.

The Daurian rhododendron is almost solely confined to the sub-alpine mountains of southern Asia, the leaves of which are smooth, naked, and dotted. According to Pallas, it first makes its appearance at the mouth of the river Jenisea, and from the river Uda in the pine woods it is very commonly met with. About Backal it is most abundant, and continues throughout the desert tracts of the Mongols, to Thibet and the North of China; at the Iena it becomes more rare, and beyond that it decreases in height, has narrower leaves, and a smaller flower. Another species is found in Kamchatka, growing in marshy mountain hollows; and the Caucasian is a native of the summits of Mount Caucasus, near the range of perpetual congelation.

The *Yellow Rhododendron (r. chrysanthum)*, is a very beautiful shrub; it is a native of Siberia, but is cultivated in this country with considerable difficulty. The leaves have an austere, bitterish taste, and have been sometimes employed in medicine, especially in rheumatism; their effect being stimulant and narcotic.

The *Common Species (r. ponticum)*, is a native of Gibraltar, and was introduced into Britain about the year 1763. Its native habitat is marshy ground, not very elevated. There are two common varieties, the blunt-leaved, and myrtle-leaved; both are of easy culture.

All the species thrive best in a peat soil, intermixed with sand, in a moderately shaded, damp situation, with an eastern or northern exposure. They may be propagated by seed, by layers, or by cuttings. The seed is either procured from America, or saved in this country; it is of very small size. Early in spring the seed is sown in pans of peat earth, which are then placed in the shade, and in winter, put under a cold frame for protection. As soon as the plants fairly come up, they must be pricked out into pots or beds; and after two years, they are to be again transplanted into wider spaces, where they may remain till required for their final destination. They commonly flower from the fourth to the seventh year of their age.

In raising from layers, the young shoots only are used, which may be laid down in June and July, when in full growth, or in the autumn. By the former plan, a year is gained, as the shoots will be rooted, and may be removed by the succeeding winter or spring; although some kinds require two years to form a sufficient number of roots. The plants, when removed, may be put into beds, and protected during the first winter with mats.

Azalea. *Pentandria, monogynia*, of Linnæus. This beautiful genus belongs to the rhododendron family. The flowers are very abundant, pretty, and odoriferous. There are several species, some natives of America, and others of India.

The Indian azalea is rather delicate in this climate, but thrives well in pots of sandy peat earth, in the green-house. Young cuttings taken off close to the plant, and placed in pots of sand, will root readily if plunged in a hotbed, under a bell glass.

The American species are more hardy, and thrive well in the open air, in a soil of peat and sand; or when this cannot be obtained, a mixture of leaf mould and sand, free from any mixture of animal manure. Most of the hardy kinds are well adapted for growing in pots, and for forcing early in spring. The deciduous varieties flower better than those which are half evergreens. Of the *nudiflora* or naked-flowered, there are a great many varieties.

Andromeda. Natural family *ericæ; decandria, monogynia*, of Linnæus. This is a genus of neat little shrubs, with heath-like flowers; chiefly natives of the marshy grounds of America, and introduced into this country about the beginning of the present century.

The moss hypnoides has the appearance of a moss; is a native of Lapland, where it spreads over extensive tracts of that country, adorning them with its beautiful red flowers.

The marsh, or wild rosemary *(polifolia)*, is a native of Britain. All the species are of easy culture from seed, or cuttings. As the seeds are extremely small, they require to be very slightly covered with soil.

Arbutus, or Strawberry Tree *(arbutus unedo)*. Natural family *ericeæ; decandria, monogynia*, of Linnæus. This is a hardy and elegant looking evergreen. The leaves are oblong, lanceolate, and serrated at the edges, the bell-shaped flowers forming a depending panicle, and the ripe berries, both of which are in profusion together, in the end of autumn, render this shrub very ornamental at that season. It is a native of the South of Europe; and is also found in a wild state near Killarney, in Ireland where it has probably been brought originally from Spain or Italy. It however flourishes there in a calcareous soil, in greater luxuriance than it is often to be met with in the woods of Italy. In both countries the fruit is eaten; and in Spain, both a sugar and spirit are extracted from it. There are three varieties of this species, the red-flowered, double-flowered, and the entire-leaved.

Some of the dwarf species of arbutus form excellent rock plants. The bearberry *(a. uva-ursi)*, has already been alluded to as a medicinal plant.

Heaths *(Erica)*. Natural family *ericæ; octandria, monogynia*, of Linnæus. This family consists of a number of species of dry, brittle-wooded, shrubby plants, generally with tubular or bell-shaped corollas, coloured white, pale bluish, pink, and scarlet. The common species, so universal over the northern parts of Europe, are in many barren regions most useful plants; nor, when examined minutely, are they less beautiful, imparting, when in flower, a rich purple glow to the surface of the otherwise rugged and barren mountains and moors. To the poor inhabitants of those mountain regions, where other woody substances are rare, the common ling or heath affords a strong thatch to their cottages, which is bound down and retained by ropes of twisted heath. The walls of those huts are also constructed of alternate layers of heath and black earth, or clay. The hardy highlander also constructs what is to him a luxurious bed, by placing a quantity of cut heath with the flowers uppermost. Strong ropes and wattled work are

also made out of this useful substance, and along with dried peat it constitutes the sole material for fuel. In many parts of Scotland, and the Western islands, a decoction of the green tops and flowers of the heather is employed for dying yarn of a yellow colour, and woollen cloth, boiled first in alum water and afterwards in a strong decoction of heath tops, comes out of a fine deep orange colour. Leather is also tanned by a decoction of this plant; Boethius mentions that the ancient Picts employed the young heather shoots and flowers for the manufacture of beer, and this practice has even come down to the present time, although it is more rarely used now than formerly. The flower, however, contains a large quantity of saccharine matter, so that bees which are reared in the moors produce an abundance of a highly flavoured honey; cattle are fed upon the tender shoots of the heath, although it is said that cows not previously accustomed to this food are so affected by its stimulating quality, as to yield at first a bloody milk; but habit and drinking plentifully of water soon cures this.

Sheep and goats also feed on heath, but they are not particularly fond of it; grouse almost entirely live on the seeds and flowers and tender tops of the heath, and in order that a constant supply may be afforded them throughout the year, the seed vessel is so formed and protected as to remain in its pericarp for twelve months, or even longer. Other birds find food and shelter in the thick covering of the heath, and the leaves are preyed upon by the great egg moth, *(phalæna quercus)*. There are three species of heath common in this country; the common, *(e. vulgaris)* the fine leaved, *(e. cinerea)* and the cross leaved, *(e. tetralix)*; both the latter have ovate bell-shaped corollas, and of the three there are two varieties, a white and red flowered.

These, with one or two other species found in other parts of Europe, were all that were known till within the last fifty or sixty years. But when the Cape of Good Hope came into the possession of the British, a number of rare and beautiful species of this genus became known, and were speedily introduced into Europe. It may serve as an easily recollected date to say, that all of them were sent home during the reign of George III., and that we owe their introduction to the industry of Mr F. Masson, a zealous botanist.* The culture of exotic heaths has been carried to a high degree of perfection in Britain. It was first practised to any great extent in the nursery of Hammersmith, and soon spread among the enterprising gardeners of England and Scotland. In the Botanic garden of Edinburgh, under the judicious management of Mr Macnab, is one of the finest collections of exotic heaths in Britain.

The native soil of the heaths is peat, and this is to be employed in their artificial culture. If any substitute can be formed for this, it is leaf mould sifted very fine, and mixed with sand. Earth of peat is obtained by collecting peats from bogs or turf from the surface of peat wastes and moist places, and laying a layer of peats or turfs in a heap to rot and moulder into earth. This they will require several years to do, but in the meanwhile a portion of mould may be obtained whenever it is wanted, by burning the turfs, and sifting the fragments. Sometimes this peat is found without any admixture of sand, at other times when streams have run into the bog or lake while the peat was forming, it is mixed with fine sand that had been held suspended in the water. This last is reckoned the best for heaths, and therefore where peat is not sandy naturally, fine white sand, or sand of any colour, provided it be not deep red, and tinged with oxide of iron, should be procured and mixed with it. This sand admits the water to penetrate into the soil and reach the roots of the plants, and also to drain away the moisture so as not to rot the roots. Pots filled with pure peat earth are apt to be either hard, dry, and impenetrable to water, or otherwise as wet as a saturated sponge. The free growing species should have rather large pots filled with good black peat, the dwarf and hardier wooded kinds require a good admixture of sand, with a smaller pot, well drained with pieces of broken potsherds and rough bits of turfy peat. They also require less water than the free growing kinds, as their native habitat at the Cape is the summits and sides of the mountains, and in the crevices of rocks, and a scanty and sandy soil.

Heath plants do not require a warm climate in winter, nor indeed at any season; if the frost is excluded, this is all that is necessary. Some species even will do to have the ground frozen about the roots without sustaining injury, provided it is not thawed in the sun, or too suddenly, or in a very warm temperature. In general the heaths may be kept in the coldest part of the greenhouse, and those not in flower in pits well protected by matting during the night, or with prepared covering of mat or straw. Too much fire-heat in winter will hurt them as much as any thing, as they only require to be kept from the frost; most of the kinds might be preserved through the winter in frames, the only difficulty is to keep them from too much wet. They all require a great deal of air and light, and therefore should be placed near the glass, and near such glass as may be opened to admit air every mild day in the year. They also require to be regularly supplied with water, not much at a time, but so frequently that the earth may never get dry, or the plant droop. Many kinds

* London Encyclopedia of Botany.

of plants, if they have suffered for want of water, may be recovered by an abundant supply, and placing them under a bell glass, in a little heat; but if once the roots of a heath are thoroughly dried, no art of the gardener will recover the plant. This is the true reason why so many heaths are destroyed when introduced into rooms as chamber plants, and also by gardeners who are ignorant of their nature.

Heaths are propagated readily by seed, by cuttings, and a few by layers. In propagating by cuttings, the tender tops are taken at whatever season of the year they begin to grow, which with most sorts is about the month of June. The strong growing kinds require the cuttings to be rather larger than the other, and some of the stunted growing kinds should be kept in the hot-house a little while when they begin to grow, to draw them to a sufficient length of young wood, or cuttings cannot be procured. Then take the extreme points of the shoots, and with a sharp pen-knife, cut off their lower ends at right angles, placing the cutting in the nail of the thumb as in cutting the nib of a pen. The cutting will be from three quarters to an inch long, strip off the leaves from the lower end to nearly half the length of the cutting, and in order that this may be done without injuring the shoot, use a sharp pen knife, or a pair of small scissors, for the least bruise or wound spoils the cutting. This done, dibble the cuttings into pots filled with moistened white sand from pits, or with any small sand from pits or rivers, or if neither of these can be procured, with powdered sand-stone; when they are all planted, water the whole to fix them properly, and when the moisture has subsided, cover them with a small crystal or greenish crystal bell-glass, fitted within the rim of the pot, and place them in the shade on a spent hot-bed, keeping them quite close till rooted. The free striking sorts will have roots in two months, and the others at different periods, from three to twelve months; most of them will be ready for transplanting into pots of the smallest size in the following March. Their rooting is easily known by their beginning to shoot, and then the bell should be taken off an hour or two every day. Many heaths ripen their seeds in this country, and seeds of the various sorts are regularly sent home by collectors at the Cape of Good Hope; these imported seeds usually arrive in winter, and they should be sown early in the following spring, in pots containing equal parts of peat earth and sand well mixed together; the seeds should be thinly covered with earth, gently pressed down, and bell-glasses placed over them as over the cuttings. The soil must be kept moderately moist by gentle waterings, and in about six or seven weeks the seeds, if fresh, will begin to come up when the glasses may be removed by degrees, and the pots kept near the glass, and shaded from the mid-day sun till autumn, when they may be transplanted into pots of the smallest size. Seeds which are ripened and saved in this country may be sown as soon as gathered, if this occurs before November; but if after this month it will then be better to defer sowing them until the following spring, when they are to be treated in the same manner as the imported seed.

Only a few of the more delicate species are propagated by layers, such as *e. massoni*, *retorta*, *petiolata*, and a few others. Even these require two years to throw out roots, and for the others the more approved method is to plant cuttings.

Henderson, of Woodhall, has been a successful cultivator of heaths for upwards of thirty years. "He says," regarding their general management,* "I keep them at all times cool and airy, opening the glasses in winter when there is no frost and letting the wind blow on them, and using no fire; but in time of frost, I never shift any plant till the pot is quite full of roots. When the plants get large, several of them will continue in good health for three or four years without shifting, and flower well. I have plants of *e. retorta* here in pots seven inches in diameter, which are very bushy, being eighteen inches across, and fourteen inches high above the pot; *e. infundibuliformis*, two feet and a half in diameter, and two feet nine inches high; *e. pilosa*, between five and six feet high, and three feet across in pots, eleven inches in diameter; these have not been shifted for five years, and are in high health, and covered with strong fine flowers, from the mouth of the pot to the top of the plant." The number of ascertained species of Cape heaths exceeds three hundred, besides varieties of them arising from cultivation. Not above twelve species are common to Europe; while the American continent is entirely destitute of any member of this family.

Heaths are by no means liable to the attacks of insects, or other vermin, which infest the more succulent shrubs. On the whole, their culture is easy, and the beauty and variety of their flowers well compensate any trouble in rearing them. Most of the species are short lived, and require therefore frequent renewals by cuttings. They do not thrive well in the smoke of the city, and require a pure and open atmosphere. They are not well adopted for chamber plants either, and to have them in perfection a separate house should be appropriated for them.

We have thus enumerated a few of the most interesting garden flowers and shrubs, and might have extended this notice to a great length. In fact, the sorts and varieties are almost unlimited, and thus a succession of new and pleasing objects

* Caledonian Horticult. Mem. Vol. III.

are always within the power of the cultivator of ornamental plants. Every family, too, has its peculiar period in the year of flowering, and thus an annual succession of plants, appearing and disappearing add to the present gratification and the excited hope of the florist. No arrangement could have been more judicious than this successive blossoming of plants, and thus the diversified beauty of these natural ornaments of the soil is prolonged from the chill of January to the latest glow of receding autumn. We shall here insert an interesting table drawn up to illustrate the monthly development of flowers.*

January.—The crocus, tulip, and some alliums beginning to emerge from the ground; if mild weather, perhaps some choice plant in flower, as the Christmas rose, daisy, winter aconite, but generally no flower is to be seen at this season.

But ever-greens now display their foliage to much advantage, especially the holly, with its coral berries, chimonanthis fragrans, and fragrans grandifloris, with the laurestinus, are in flower. The glossy leaves of the Portuguese laurel glisten in a lively cheerful manner in the gleams of sunshine with which we are favoured even in this month; those of the common laurel do the same. In the green-house, the camellias are in full bloom, and some heaths and Australian plants. In the stove strelitzia, and some other plants. From the pits and hotbeds in the reserve garden, forced roses, hyacinths, and other bulbs, with early mignonette, are ready to adorn the cabinet or drawing room.

February.—The snow drop, Christmas rose, and winter aconite, in flower. The crocus, crown imperial, and other bulbs, fast advancing, if the weather be favourable. The buds of the weeping-willow bursting, or about to burst, a proof that this species has not yet become acclimated to Britain. The male flowers of the hazel, yew, erica carnea, and some other shrubs, appear. In the green-house, camellias and heaths are in great beauty, as also some species of oxalis, protea, &c. In the stove, strelitzia, and some bulbs and succulents, with forced flowers from the pits, as in January. The lark sings about the beginning of the month, and the thrush about the middle.

March.—Among florist's flowers, the crocus, scilla, some hyacinths, and crown imperials, and also the primrose and polyanthus are in bloom in the latter half of the month. Saxifraga oppositifolia, among the alpines; and viola odorata, in a warm border or on rock work. Saxifraga retusa, chrysosplenium oppositifolium, and alternifolium. Some pines, poplars, and willows show their catkins; the sloe, cornelian cherry, mezereon, different varieties, daphne pontica, and collina, the lonicera nigra, and rosemary in flower. In the green-house, some camellias still in flower, numerous heaths in great beauty, also aletris, lachenalia, oxalis, some geraniums. In the stove, some scitamineæ, and bulbs, solandra grandiflora, eugenia, and justicia. The ring dove begins to coo in the first week of the month.

April.—The hyacinth, narcissus, auricula, polyanthus, forming the most valued florist's flowers, are in perfection in the course of this month, also the scilla, fritillaria, wall-flower, daisy, pulmonaria officinalis, omphalodes verna, various saxifrages, and other alpines. Most of the wild fruit trees, as crabs, pears, cherries, and those allied species, are now in flower; most of the willows, birches, elms, and oaks show their catkins. Among shrubs, the honey-suckle, some robinias, andromedas, daphnes, ericas, and xanthoriza apiifolia, are in flower. In the green-house, above thirty species of ericæ, and nearly as many of the ixiæ family, with lachenalia, oxalis, acacia, and various other genera in perfection. In the stove, dracena, bromelia, kempferia, and stapelias. Abundance of forced articles, including annuals, as sweet peas, larkspurs, &c. in flower. Most of the British summer birds of passage arrive during this month.

May.—The auricula stage still a fine object in the first week, and the polyanthus and narcissus family not yet over. The collections of tulips, anemones, and pæonies in full beauty from the middle of the month. Many showy herbaceous plants, as statice, lychnus, phlox, come into flower. Among the aquatic, Huttonia palustris, and ranunculus aquatilis. The horse-chestnut, hawthorn, sorbus, mespilus, and snow-drop tree in great beauty. Among the American shrubs, several species of magnolia, azalea, kalmia, andromeda, and many common shrubs; the lilac, spiræa, guelder rose, honey-suckle, the cinnamon, Scotch, burnet-leaved, and monthly roses. In the green-house a fine display of heaths, ixiæ, and gladioli; also several geraniums, salviæ, proteæ. In the stove, passion flowers, justicia, heliconia, and various other genera. From the forcing department, pelargoniums, and other green-house plants; hydrangeas, balsams, and tender annuals. Most of the singing birds are in this month in full note.

June.—The collection of peonies and anemones not yet faded. Those of ranuncules, iris, xiphium, and xiphioides, and of the hardy gladioli, and ixeæ, in full beauty; assortments of pink and sweet-william, in flower towards the end of the month; also, hemerocallis, aquilegia, campanula, veronica, and many showy herbaceous perennials: some biennials, as agrostemma and abyssum; annuals, as crepis, silene; aquatics, as butomus, hydrocharis, potamogeton, viola, saxifraga, and various alpines. Heart'sease now in greatest beauty.

* Loudon's Gardener's Magazine.

The lime, laburnum, and fringe tree, in flower towards the middle of the month; many sorts of roses, andromeda, magnolia, rhododendron maximum, and ponticum, azalea, &c. Of common shrubs, cistus, helianthemum, erica, dogwood, elder, cytisus, spiræa, lonicera.

In the green-house, chiefly tender annuals from the reserve garden, the proper inhabitants being in the open garden; and there the heaths, geraniums, citrus tribe, diosmæ, proteæ, in great beauty. In the stove, amaryllis and other bulbs; also the aloe, pepper, and other succulents; eugenias, epidendrums, cassia, cistrum, &c.

The goat-sucker, or fern owl *(caprimulgus Europæus)*, heard in the evenings of the first week; it is sometimes heard as early as the middle of May. Most singing birds leave off singing about the end of the month.

July.—The flowers of this month are the pink, and carnation, the white martagon, and the tiger lilies, the Brompton stock, larkspur, lupines, and other biennials and annuals. More herbaceous plants are now in flower than in any other month, as chelone, delphinum, dictamnus, gentiana, statice, phlox, silene, salvia, veronica, saxifraga. The most showy of the aquatics, as nymphæa, nuphar, villarsia, alisma, calla, stratiotes, myosotis, polyganum, amphibium, are now in flower; several varieties of Georgina, variabilis, and various alpines. The tulip tree, magnolia, kalmia, andromeda, azalea, erica, rhododendron, and other American or peat earth shrubs, in flower. Among the more common kinds, the roses are now in full splendour, the white jasmine, honeysuckles, clematis, spartium, gleditschia, triacanthus, cistus, lycium, and a great variety of others of less note.

The green-house is now filled with tender annuals, as balsams, globe amaranthus, coxcombs, ice-plants, sensitive mimosas, and probably with some of the stove plants. In the open air, geraniums will be in great beauty, and also heaths, misembryanthemum, melaleuca, metrosideros, protea, and numerous others. There are numerous stove plants now in flower, as canna, poivrea, passiflora, nelumbium, gloriosa, amaryllis, pancratium, cactus, euphorbia, myrtus, ipimæa, justicia.

Showy butterflies and moths appear in the beginning, the large dragon fly towards the end of the month.

August.—The prevailing garden flowers of this month are the holy-hocks, pyramidal bellflowers, lobelias, annual stocks, the poppies, lilium canadense, and four other American species. Numerous herbaceous plants are now in flower that first appear in July; and various species of aster, astrantia, helianthus, narthecium ossifragum, and numerous others, first bloom in this month. Among the aquatics may be mentioned lobelia, dortmanna, calla palustris, and several species of potamogeton. Scarcely any trees are now in bloom; but of American shrubs there are various sorts, as azalea, clethra, and magnolia, in perfection; and of select common shrubs, the hibiscus, with its numerous and beautiful varieties; the rose, the honey-suckle, yellow jasmine, clematis, spiræa, and dwarf pavia, form a greater show in the shrubbery and rosary than in any other month.

The green-house the same as last month. In the open air, the plants growing vigorously; but except the geraniums and heaths, and some succulents, not many species in flower. In the stove, asclepias, convolvulus, pancratium, lagerstrœmia, passiflora, plumbago, and numerous other genera, in flower.

The robin red-breast sings about the last week; and butterflies, moths, and dragon flies, abound during the whole month.

September.—The florist's flowers of this month are the Georginas, which flower also when excited by artificial heat, previously to planting in the open ground in July and August; but planted in the usual way, are now in perfection. Among the bulbs, there are the acis autumnalis, narcissus serotinus, and scilla autumnalis; the China aster, in all its varieties, is now in perfection. Among the herbaceous perennials, aster, solidago, helianthus, gentiana, phlox, and asphodelus, are the chief sorts.

Aralia spinosa, some azaleas, and kalmia, Lord Macartney's rose, and another rose or two, are in flower during the greater part of this month. But the chief ornament of the shrubbery is the fruit of the mountain ash, viburnum, cratægi, pyracantha, Siberian crabs, sorb, lonicera, apple rose, elder. The green-house plants are now generally returned to their winter habitation in course of this month; some heaths, and pelargoniums, and a few other species, in flower. There are not many stove plants in flower at this season. Amarillas, passiflora, and some succulents, may be mentioned. Tender annuals are supplied from the forcing department of the reserve garden, for decorating the plant cabinet, conservatory, or drawing-room.

October. The garden flowers of this month are the Chinese chrysanthemums, some of the hardier of which will now flower in the open air, and the others under a glass case, or in the green-house; the colchicum autumnale, crocus, cyclamen europeum, and sternbergia lutea; the principal herbaceous plants are aster, solidago, helianthus, heliopsis, coreopsis actinomeris, polymnia, gentiana, and some others. Arbutus unedo is the only beautiful shrub in flower, and also in fruit at this season; gordonia, rhamnus, baccharis, clematis, and the common ivy, are also in flower. Any spare room in the green-house is now occupied with chrysanthemums, and some georginas, raised in pots and placed out of

the reach of frost, to prolong their bloom. A few heaths, statice, and pelargoniums still in bloom. In the stove, vinea, stapelia, romanthera, and a few others. The increasing coolness of the weather conduces to the retreat of a considerable number of insects.

Flies of various species, and the cristalis tenax, which much resembles a drone bee, are very abundant in sunny days upon the flowers of the autumnal flowering compositæ.

November and December.—The remains of the plants of last month in greater or less beauty, according to the weather, and perhaps a few plants unnaturally in bloom. In mild winters stocks of several sorts, larkspurs, violets, India pinks, pot marigolds, polyanthuses, primroses, gentians, monthly roses, yellow amaryllis, daisies, and various other plants. In the shrubbery, clematis calycina, and perhaps a few plants unnaturally in bloom. In the greenhouse, dryandria, erica, lantana, and camellias, about the middle of December. In the stove, all the species of strelitzia; also stapelias, amarillis, aletris, and one or two other bulbs. From the forcing department, hyacinths, Persian iris, and other bulbs, monthly roses, the Provence rose, and other shrubs and flowers.

The subjoined table, drawn up by Linnæus, shows the diurnal expansion of the corollas of several species of flowers.

HOROLOGIUM FLORÆ,

OR A TABLE OF THE HOURS AT WHICH CERTAIN PLANTS EXPAND AND SHUT, AT UPSAL, IN THE 60th DEGREE OF NORTH LAT.

Hours at which the Flowers open.	NAMES OF PLANTS.	Hours at which the flowers close.	
A. M.		A. M.	P. M.
3 to 4	Tragopogon pratense	9 to 10	..
4 to 5	Leontodon tuberosum	..	3
4 to 5	Pieris hieracioides	..	..
4 to 5	Cichorium Intybus	10	..
4 to 5	Crepis tectorum	10 to 12	..
4 to 6	Picridium tingitanum	10	..
5	Sonchus oleraceus	11 to 12	..
5	Papaver nudicaule	..	7
5	Hemerocallis fulva	..	7 to 8
5 to 6	Leontodon taraxacum	8 to 12	..
5 to 6	Crepis alpina	11	..
5 to 6	Rhagadiolus edulis	10	1
6	Hypochæris maculata	..	4 to 5
6	Hieracium umbellatum	..	[illegible]
6 to 7	Hieracium murorum	..	[illegible]
6 to 7	Hieracium Pilosella	..	3 to 4
6 to 7	Crepis rubra	..	1 to 2
6 to 7	Sonchus arvensis	10 to 12	..
6 to 8	Alyssum utriculatum	..	4
7	Leontodon	..	3
7	Sonchus lapponicus	12	..
7	Lactuca sativa	10	..
7	Calendula pluvialis	..	3 to 4
7	Nymphæa alba	..	5
7	Anthericum ramosum	..	3 to 4
7 to 8	Mesembryanthemum barbatum	..	2
7 to 8	Mesembryanthemum linguiforme	..	[illegible]
8	Hieracium auricula	..	2
[illegible]	Anagallis arvensis	..	..
8	Dianthus prolifer	..	1
[illegible]	Hieracium chondrilloides	..	1
9	Calendula arvensis	12	8
9 to 10	Arenaria	..	2 to 3
9 to 10	Mesembryanthemum crystallinum		2 to 4
10 to 11	Mesembryanthemum nodiflorum	..	[illegible]
		..	
P. M.			..
5	Nyctago hortensis	..	..
6	Geranium triste	..	..
9 to 10	Silene noctiflora	..	..
9 to 10	Cactus grandiflorus	.	12

CHAP. LV.

NATURAL FAMILIES OF DICOTYLEDONOUS PLANTS.

In chapter xxv. we gave a summary of the natural families forming the second great division of plants, the monocotyledonous; in this we shall enumerate the families composing the third or dicotyledonous division.

This division, as already mentioned, comprehends all those plants whose embryo has two seed-lobes, or cotyledons, and comprehends the greater number of flowering trees and shrubs, as well as a great proportion of other flowering herbaceous plants.

In dicotyledonous plants, the stem is composed internally of concentric layers, or circles; the veins of the leaves are branched laterally; there is generally both a calyx and corolla, and two cotyledons in the embryo. In a single family—the coniferæ, these cotyledons exceed two.

Aristolochiæ, Jussieu. This family is composed of only two genera, *aristolochia* and *asarum*. It consists of herbaceous, or frutescent and twining plants, bearing alternate, entire leaves, and axillar flowers. Their calyx is regular, with three valvar divisions, or irregular, tubular, and forming a lip of very diversified figure. The stamina, ten or twelve in number, are inserted upon the ovary. They are sometimes free and distinct, sometimes intimately united with the style and stigma, and thus forming a kind of nipple placed at the summit of the ovary. On its lateral parts this nipple bears the six stamina, which are bilocular, and at its summit is terminated by six small lobes, which may be considered as the stigmas. The fruit is a capsule, or a berry with three or six cells, each containing a very large number of seeds, containing a very small embryo, placed in a fleshy endosperm.

Jussieu united to this family the genus *cytinus*, which has become the type of a distinct family, under the name of *cytineæ*.

The roots of the plants of this family are generally tonic and stimulant, and have also been employed in uterine affections. The root of *aristolochia serpentaria*, which is aromatic, with a pungent taste, has been used with success in typhus. Asarabacca is diuretic, and is employed as an external application for ophthalmia.

Cytineæ, Brown. The flowers are unisexual, monœcious, or diœcious. The calyx is adherent, rarely free *(nepenthes)*. Its limb has four or five divisions. The stamina vary from eight to sixteen, sometimes a greater number. They are monadelphous. The ovary is inferior, excepting in *nepenthes*, with one or four cells. The seeds are attached to parietal trophosperms. The style

is cylindrical, rarely wanting, and is terminated by a stigma, of which the lobes are equal to that of the trophosperms. The seeds have an axile cylindrical embryo, placed in the centre of a fleshy endosperm.

The genera which compose this small family, are *cytinus*, *rafflesia*, and *nepenthes*. The first two are parasitic, and destitute of leaves. The other is remarkable for having its leaves terminated by a kind of bottle, which shuts by means of a movable lid; or, according to some views, this lid is reckoned the true leaf. This family is distinguished from the aristolochiæ by having its seeds attached to parietal trophosperms, by its unisexual flowers, and by the quaternary or quinary number of the different parts of the flower.

The active properties of these plants are little known; nor have they been appropriated to any useful purpose.

Santalaceæ, Brown. These are herbaceous, or frutescent plants, or trees with alternate, rarely opposite leaves; destitute of stipules, and small flowers, either solitary, or disposed in a spike or sertule. Their calyx is superior, with four or five valvar divisions. The stamina, four or five in number, are opposite to the divisions of the calyx, and inserted at their base. The ovary is inferior, with a single cell, containing one, two, or four ovules, which hang from the summit of a filiform podosperm, springing from the bottom of the cell. The style is simple, terminated by a lobed stigma. The fruit is indehiscent, monospermous, sometimes slightly fleshy. The seed presents an axile embryo in a fleshy endosperm.

This family was established by Brown, and is composed of the genera *thessium*, *quinchamalium*, *osyris*, and *fusanus*, placed by Jussieu in the family of eleagneæ, and of the genus *santalum*, which formed part of the onagrariæ. They are trees, or dwarf shrubs, chiefly natives of the Cape, New Holland, and India, a few only being found in Europe and America. *Santalum album* is esteemed for its perfume. The others possess few known virtues.

Elæagneæ, A. Rich. Trees or shrubs, with alternate or opposite leaves, which are destitute of stipules, and entire. Their flowers are diœcious or hermaphrodite; the male ones sometimes disposed in a kind of catkin. The calyx is monosepalous, and tubular; its limb entire, or with two or four divisions. The stamina, from three to eight in number, are introsal, and nearly sessile on the inner wall of the calyx. In the female flowers, the tube of the calyx directly covers the ovary, but without adhering to it. The entrance of the tube is sometimes partly closed by a variously lobed disk. The ovary is free, unilocular, and contains a single ascending, pedicellate ovary. The style is short the stigma simple, elongated, and linguiform. The fruit is a crustaceous akenium, covered by the calyx, which has become fleshy. The seed contains in a very thin endosperm, an embryo which has the same direction.

The genera are *elæagnus*, *hippophæ*, *shepherdia*, and *conuleum*. They are of little note. The berries of *hippophæ rhamnoides*, are used as an acid sauce in Sweden.

Thymeleæ, Jussieu. Shrubs, rarely herbaceous plants, with alternate, or opposite, entire leaves, having the flowers terminal or axillar, in sertules, spikes, solitary, or several together in the axils of the leaves. The calyx is generally coloured, and petaloid, more or less tubular, with four or five divisions, which are imbricated before expansion. The stamina, generally eight in number, disposed in two series, or four, or only two, are inserted sessile upon the inner wall of the calyx. The ovary is unilocular, and contains a single pendent ovule. The style is simple, terminated by an equally simple stigma. The fruit is a kind of nut, slightly fleshy externally. The embryo, which is reversed like the seed, is contained in a fleshy and thin endosperm.

The principal genera of this family are: *daphne*, *stellera*, *passerina*, *pimelia*, *struthiola*, &c.

The bark is extremely acrid, or caustic, blistering the skin. That of *daphne mezereon* is employed in medicine. The lace tree, *daphne laghetto*, is remarkable for the reticulated appearance of the liber, which may be pulled out in many successive layers, resembling a piece of lace.

Proteaceæ, Jussieu. The proteacea are all shrubs or trees, which grow in abundance at the Cape of Good Hope, and in New Holland. Their leaves are alternate, sometimes nearly verticellate, or imbricate. Their flowers, which are generally hermaphrodite, rarely unisexual, are sometimes grouped in the axillæ of the leaves, sometimes collected into a kind of cone or catkin. Their calyx consists of four linear sepals, sometimes united, and forming a tubular calyx, with four more or less deep and valvar divisions. The stamina, four in number, are opposite to the sepals, and almost sessile at the summit of their inner surface. The ovary is free, with a single cell, containing a seed attached about the middle of its height. The style is terminated by a usually simple stigma. The fruits are capsules of various forms, unilocular, and monospermous, opening on one side by a longitudinal suture, and by their aggregation, sometimes forming a kind of cone. The seed, which is occasionally winged, consists of a straight embryo destitute of endosperm.

The genera of this family are numerous. We shall here mention as examples: *protea*, *petrophila*, *banksia*, *grevillea*, *embothrium*, *hakea*, &c.

This family, on account of the form of its calyx, its stamina sessile at the summit of the sepals, and especially its general aspect, cannot be confounded with any other.

From their beauty, they are esteemed in ornamental gardening. They are not known to possess any other valuable properties. The bark is astringent, and that of one species yields a pink dye.

LAURINEÆ, Jussieu. Trees or shrubs with alternate, rarely opposite, entire or lobed, very frequently coriaceous, persistent, dotted leaves. The flowers, sometimes unisexual, are disposed in panicles or cymes. The calyx is monosepalous, with four or six deep divisions, imbricated by their edges previous to expansion. The stamina are from eight to twelve, inserted at the base of the calyx. Their filaments have at their base two pedicellate appendages, of diversified form, and appearing to be abortive stamina. The anthers are terminal, opening by means of two or four valves, which rise from the base to the summit. The ovary is free, unilocular, containing a single pendent ovule. The style is more or less elongated, and is terminated by a simple stigma. The fruit is fleshy, accompanied at its base by the calyx, which forms a kind of capula. The seed contains under its proper integument a very large embryo, reversed like the seed, with extremely thick and fleshy cotyledons.

The type of this family is formed by the laurel, and some genera allied to it, as *borbonia, ocotea*, and *cassytha*. The last mentioned genus is remarkable for being composed of herbaceous twining and leafless plants. Jussieu united *myristica* with the laurineæ, but Mr Brown has justly removed it to form a distinct family under the name of *myristiceæ*. The family of laurineæ is chiefly characterised by its peculiar aspect, and by its stamina, the anthers of which open by means of valves. The same character is observed in the hamamelideæ and Berberideæ; but the last mentioned family belongs to the class of hypogynous polypetalous dicotyledones.

Many of the species are aromatic, pungent, and stomachic. Cinnamon, cassia, and camphor, are obtained from various species of Laurus. The bark of *laurus benzoin* is employed in America in intermittent fevers.

MYRISTICEÆ, Brown. Tropical trees with alternate, entire leaves, which are not dotted, and diœcious, axillar, or terminal flowers, variously disposed. Their monosepalous calyx has four valvar divisions. In the male flowers there are from three to twelve monadelphous stamina; the anthers placed close together, often united, and opening by a longitudinal groove. In the female flowers the ovary is free, with a single cell, containing a single erect ovule. The style is very short, terminated by a lobed stigma. The fruit is a kind of capsular berry, opening with two valves. The seed is covered by a fleshy arillus, divided into a great number of shreds. The endosperm is fleshy or very hard, mottled, and contains towards its base a very small erect embryo.

The type of this family is the nutmeg tree. It is very distinct from the laurineæ, in having its calyx with three divisions; its stamina monadelphous, and opening by a longitudinal groove; its seed erect, and furnished with an arillus; and its embryo very small, and contained in a hard and marbled endosperm.

Nutmeg and mace, the fruit of *myristica moschata*, are possessed of aromatic and stimulant properties.

POLYGONEÆ, Jussieu. Herbaceous, rarely suffrutescent plants, with alternate leaves, sheathing at their base, or adhering to a membranous and stipular sheath, rolled downwards upon their middle nerve when young. Flowers sometimes unisexual, disposed in cylindrical spikes, or in terminal clusters. Calyx monosepalous, with from four to six segments, sometimes disposed in two rows, and imbricated previous to their evolution. Stamina from four to nine, free, and with anthers opening longitudinally. Ovary free, unilocular, with a single erect ovule; the fruit, which is pretty frequently triangular, is dry and indehiscent, sometimes covered by the persistent calyx. The seed contains, in a farinaceous, sometimes very thin endosperm, a reversed and often unilateral embryo.

This family is composed of the genera *polygonum, rumex, rheum, cocoloba*, &c. It is distinguished from the chenopodeæ, by the stipular sheath of its leaves, its erect ovule, and its reversed embryo.

The roots of many species are astringent, as of the *rumices* generally. Those of *rheum* are well known as a common purgative. *Polygonum hydropiper* is extremely acrid, and blisters the mouth when tasted. The seeds of *polygonum fagopyrum*, or buck-wheat, which is extensively cultivated in France, are used as food. The leaves and young stems of *rumex acetosa* and *acetosella*, are agreeably acid, as are those of *oxyria reniformis*.

ATRIPLICES, Jussieu. CHENOPODEÆ, Decandolle. Herbaceous or woody plants, with alternate or opposite leaves, destitute of stipules. The flowers are small, sometimes unisexual, disposed in branched clusters, or grouped in the axilla of the leaves. The calyx is monosepalous, sometimes tubular at the base, with three, four, or five, more or less deep, persistent lobes. The stamina vary from one to five. They are inserted either at the base of the calyx, or under the ovary, and are opposite to the lobes of the calyx. The ovary is free, unilocular, monospermous,

containing a single erect ovule, which is sometimes supported upon a more or less long and slender podosperm. The style, which is rarely simple, has two, three, or four divisions, each terminated by a subulate stigma. The fruit is an akenium, or a small berry. The seed is composed beneath its proper integument of a slender cylindrical embryo, curved back upon a farinaceous endosperm, or spirally twisted, and sometimes without endosperm.

This family is composed of the genera *chenopodium*, *atriplex*, *salsola*, *beta*, *salicornia*, &c. It is closely connected, on the one hand, with the polygoneæ, which differ from it in the stipular sheath of their leaves, their straight embryo, and their superior radicle; and, on the other, with the amaranthaceæ, from which, in fact, they differ only in their general aspect, and in some characters of little importance. The chenopodeæ present examples of genera having a perigynous insertion, such as *beta*, *blitum*, *spinacia*, and others in greater number, which have the insertion hypogynous, such as *rivinia*, *salsola*, *camphorosma*, *chenopodium*, &c.

The maritime species yield soda, and are employed in the manufacture of barilla. From the root of *beta vulgaris*, sugar is obtained. The roots and herbage of many species are employed as articles of food. *Chenopodium olidum* is remarkable for its disagreeable smell, resembling that of putrid fish.

Amaranthaceæ, Brown. *(Part of the Amaranthaceæ of Jussieu.)* The amaranthaceæ are herbaceous, or suffrutescent plants, bearing alternate or opposite leaves, sometimes furnished with scariose stipules. The flowers are small, often hermaphrodite, sometimes unisexual, disposed in spikes, panicles, or capitula, and furnished with scales, by which they are separated. The calyx is monosepalous, often persistent, with four or five very deep divisions. The stamina vary from three to five. Their filaments are sometimes free, sometimes monadelphous, and occasionally form a membranous tube, lobed at its summit, and bearing the anthers on its inner surface. The ovary is free, unilocular, containing a single erect ovule, sometimes borne upon a very long, recurved podosperm, at the summit of which they hang. The style is simple or wanting, and is terminated by two or three stigmas. The fruit, which is generally surrounded by the calyx, is an akenium or a small pyxidium, opening by means of a lid. The embryo is cylindrical, elongated, recurved around a farinaceous endosperm.

This family is composed of the genera *amaranthus*, *celosia*, *gomphrena*, *achyranthes*, &c., and is closely allied to the chenopodeæ.

From the amaranthaceæ are separated certain genera with perigynous stamina, as *illecebrum*, *paronychia*, &c., which, together with some others removed from the caryophylleæ, form a distinct family under the name of paronychieæ.

Most of this family are weeds. Several species are used as salads, or pot-herbs. Some are cultivated in the flower garden, as the globe amaranthus, the love-lies-bleeding, and the cock's-combs.

Nyctagineæ, Jussieu. The nyctagineæ are herbaceous plants, shrubs, or even trees, with simple, generally opposite, sometimes alternate leaves. The flowers are axillar, or terminal, often collected several together in a common, proper, and calciform involucre. Their calyx is monosepalous, coloured, often tubular, bulging at its lower part, which is often thicker, and persists after the fall of the upper part. The limb is more or less divided into plaited lobes. The stamina vary from five to ten, and are inserted upon the upper edge of a kind of hypogynous disk, often in the form of a capsule. The ovary is one-celled, and contains an erect ovule. The style and stigma are simple. The fruit is a cariopsis, covered by the disk and the lower part of calyx, which are crustaceous, and form a kind of accessory pericarp. The true pericarp is thin, and adheres to the proper tegument of the seed. The seed is composed of an embryo, curved upon itself, having its radicle bent back upon the face of one of the cotyledons, and thus embracing the endosperm, which is central.

The genera *nyctago*, *allionia*, *pisonia*, *boerhavia*, &c., belong to this family. Some authors, setting out with the genera whose involucre is uniflorous, as in nyctago, or the marvel of Peru, have considered the involucre as a calyx, and the calyx as a corolla; but analogy, and especially the genera which have an involucre containing several flowers, prove the perianth to be really single. The roots are generally purgative; most of the species are mere weeds.

Plantagineæ, Jussieu. A small family of plants containing only the genera *plantago* and *littorella*. The flowers are hermaphrodite, unisexual in *littorella*, forming simple, cylindrical, elongated, or globular spikes; the flowers rarely solitary. The calyx has four deep, persistent divisions, or four unequal sepals, in the form of scales, two of them more external. The corolla is monopetalous, tubular, with four regular divisions, seldom entire at its summit. In the genus *plantago*, the corolla gives attachment to four protruded stamina, which in *littorella* spring from the receptacle. The ovary is free, with one, two, or very rarely four cells, containing one or more ovules. The style is capillar, terminated by a simple subulate stigma, rarely bifid at the tip. The fruit is a small pyxidium, covered by the persistent corolla. The seeds are composed of a proper integument, which covers

a fleshy endosperm, at the centre of which is a cylindrical axile and homotrope embryo.

The plantagineæ are herbaceous, rarely suffrutescent plants, often stemless, and having only radical peduncles, which bear spikes of very dense flowers. Their leaves are often radical, entire toothed, or variously incised. They grow in all latitudes.

The seeds of *plantago ispaghula* and *psyllium*, form, with water, a mucilage, which, in India, is employed as a demulcent. The herbage is bitter, but without remarkable properties.

Plumbaginæ, Jussieu. A natural family of dicotyledonous plants, placed by some among the apetalæ, and by others among the monopetalæ. They are herbaceous or suffrutescent plants, with alternate leaves, sometimes all collected at the base of the stem, and sheathing. The flowers are disposed in spikes, or in branched and terminal racemes. Their calyx is monosepalous, tubular, plicate and persistent, generally with five divisions. The corolla is sometimes monopetalous, sometimes formed of five equal petals, which not unfrequently are united together at the base. The stamina, generally five in number, and opposite to the divisions of the corolla, are epipetalous, when the corolla is polypetalous, and immediately hypogynous when the corolla is monopetalous (which is the reverse of the general disposition). The ovary is free, pretty frequently five-cornered, with a single cell, containing an ovule hanging to the summit of a filiform and basilar podosperm. The styles, from three to five in number, are terminated by an equal number of subulate stigmas. The fruit is an akenium enveloped by the calyx. The seed is composed of a proper integument and a farinaceous endosperm, in the centre of which is an embryo having the same direction as the seed.

This little family is composed of the genera *plumbago*, *statice*, *limonium*, *vogelia* of Lamarck, *theta* of Loureiro, *ægialitis* of Brown. It differs from the nyctagineæ, which are monoperianthous, in having its ovule supported upon a long podosperm, at the summit of which it hangs, in having several styles and stigmas, in having the embryo straight and not bent upon itself. Their virtues are tonic, astringent, or acrid. The root of *statice caroliniana* is powerfully astringent. Those of several species of *plumbago* are extremely caustic, and have been employed as rubefacients and vesicatories, as well as in the treatment of ulcers.

Primulaceæ, Vent. Lysimachiæ, Jussieu. The primulaceæ are annual or perennial plants, with opposite or verticillate, very rarely scattered, leaves. Their flowers are disposed in spikes, or in axillar or terminal racemes; sometimes they are solitary, or variously grouped. The calyx is monosepalous, with five or four divisions; the corolla monopetalous and regular, sometimes tubular at the base, sometimes very deeply divided into five segments. The stamina, five in number, are either free or monadelphous, and are inserted at the upper part of the tube of the corolla, or at the base of its divisions. They are opposite to the divisions, and their introrsal anthers open each by a longitudinal groove. The ovary is free, with a single cell containing a very great number of ovules attached to a central trophosperm. The style and the stigma are simple. The fruit is a unilocular, polyspermous capsule, opening by three or five valves, or an operculate pyxidium. The seeds present a cylindrical embryo placed transversely to the hilum in a fleshy endosperm.

The principal genera which compose this family are: *primula*, *lysimachia*, *hottonia*, *anagallis*, *cyclamen*, *centunculus*, &c. *Samolus* has also been united to it, although its ovary is, to a great extent, adherent to the calyx. In all its other characters, however, it agrees with this family.

The primulaceæ are very well characterized by their stamina being opposite to the divisions of the corolla, their unilocular capsule, the seeds of which are attached to a central trophosperm, and their embryo placed transversely before the hilum. In these different characters, they come very near the myrsineæ, which differ in having the fruit fleshy, and the seeds immersed in pits of the trophosperm, which is fleshy and very large.

The root of *Cyclamen* is acrid, but the family is not distinguished by any remarkable properties. The primrose, and many other species, are beautiful garden flowers. Hollonia is a beautiful aquatic, common in England.

Lentibulariæ, Rich. A small family, consisting of only two genera, *utricularia* and *pinguicula*, which were formerly placed at the end of the primulaceæ. They are small herbaceous plants, growing among water, or in moist and inundated places. Their leaves are either clustered in a rosaceous form, at the base of the stems, or divided into capillar, and often vesicular segments, in the species which grow immersed in the water. The stem is always simple, bearing one or several flowers at its extremity. The calyx is persistent, monosepalous, and as it were divided into two lips. The corolla is monopetalous, irregular, spurred, and also two-lipped. The stamina, two in number, are included, and are inserted at the very base of the corolla. The ovary is one-celled, and contains a great number of ovules attached to a central trophosperm. The style is simple and very short; the stigma bilamellate. The fruit is a unilocular, polyspermous capsule, opening either transversely, or by a longitudinal slit, which divides its summit into two valves. The

seeds present an embryo immediately covered by the proper integument.

This small family is distinguished from the primulaceæ by its irregular corolla, its two stamina, and its embryo destitute of endosperm; and from the antirrhinæ by its one-celled fruit, of which the trophosperm is central, and its embryo destitute of endosperm.

Globulariæ, De Cand. The genus *globularia*, which was at first placed among the primulaceæ, constitutes of itself this little family, of which the following are the principal characters. The calyx is monosepalous, tubular, persistent, with five divisions. The corolla is monopetalous tubular, irregular, with five narrow, unequal segments, disposed so as to form two lips. The stamina, four or five in number, are alternate with the divisions of the corolla. The ovary is unilocular, containing a single pendent ovule. The style is slender, and terminated by a stigma with two tubular and unequal divisions. At the base of the ovary is a small unilateral disk. The fruit is an akenium covered by the calyx. The embryo is nearly cylindrical, axile, and placed in a fleshy endosperm.

The globulariæ are herbaceous or suffrutescent plants, with leaves all radical or alternate, and small bluish flowers collected into a globular capitulum, and accompanied with bracteas. They differ from the primulaceæ in having their corolla irregular, their stamina alternate, and their ovary containing a single reversed ovule.

Orobancheæ, Vent. Plants sometimes parasitic on the roots of other plants, sometimes growing in the earth. Their stem is sometimes destitute of leaves, which are substituted by scales. The flowers, which are accompanied by bracteas, are terminal, sometimes solitary, sometimes disposed in a spike. The calyx is monosepalous and tubular, or divided to the base into distinct sepals. The corolla is monopetalous, irregular, often two-lipped. The stamina are generally didynamous. The ovary, which is applied upon a hypogynous and annular disk, has only one cell, which contains very numerous ovules attached to two parietal trophosperms, bifid on their free side. The style is terminated by a stigma with two unequal lobes. The fruit is a unilocular capsule, opening into two valves, each of which bears a trophosperm on the middle of its inner face. The seeds, which have a double integument, present a fleshy endosperm, which bears a very small embryo, placed in a depression in its upper and lateral part.

The genera *orobanche*, *phelippea*, *lathræa*, &c., form this family, which differs from the scrophularinæ in its unilocular ovary, the position of the embryo, and especially the general appearance of the plants of which it is composed.

Astringent, but of little importance in a medical point of view.

Scrophularinæ, Brown. *Scrophulariæ* and *Pediculares*, Jussieu. Herbs or shrubs, with simple leaves, which are often opposite, sometimes alternate, and flowers disposed in spikes or terminal racemes. Their calyx is monosepalous, persistent, with four or five unequal divisions. The corolla is monopetalous, irregular, two-lipped, and often personate. The stamina from two to four in number, are in the latter case didynamous. The ovary, applied upon a hypogynous disk, has two polyspermous cells. The style is simple, terminated by a two-lobed stigma. The fruit is a bilocular capsule, varying much in its mode of dehiscence. Sometimes it opens by holes formed towards the summit, sometimes by irregular plates, sometimes by two or four valves, each bearing the half of the dissepiment on the middle of its inner face, or opposite to the dissepiment which remains entire. The seeds contain, under their proper integument, a kernel, composed of a fleshy endosperm, which encloses a straight cylindrical embryo, having its radicle directed towards the hilum, or opposite to that point of attachment.

"We have followed," says Richard, "the example of Mr Brown, who unites into one the two families proposed by Jussieu, under the names of *scrophulariæ* and *pediculares*. The principal difference which served to distinguish these two families, was derived from the mode of dehiscence of the capsule, which, in the scrophulariæ, takes place by holes or valves opposite to the dissepiment, which remains untouched; whereas, in the pediculares, each valve bears, on the middle of its inner surface, the half of the septum. But these differences, which appear very decided, present numerous shades; and, for example, in the genus *veronica*, we find almost all modifications of them. But we have observed another difference between these two groups, which we have not had an opportunity of remarking in all the genera, but which has appeared to us constant in all those of which we have examined the seed, and which is, that in the pediculares of Jussieu, the embryo has always a direction the reverse of that of the seed, that is, its cotyledons are turned towards the hilum, whereas the contrary happens in the scrophulariæ.

1. Pediculares: *pedicularis*, *rhinanthus*, *melampyrum*, *veronica*, *euphrasia*, *erinus*, &c.

2. Scrophulariæ: *antirrhinum*, *linaria*, *scrophularia*, *digitalis*, *gratiola*, &c.

A great proportion of the didynamia angiospermia of Linnæus, belong to this family; capsular fruit, and didynamous stamens, being among the most obvious characteristics of the order. The species are generally herbs, rarely shrubs, and are found in mountains, valleys, ditches, and way-sides, in all parts of the world.

Pedicularis, *rhinanthu*, *melampyrum*, and

euphrasia, are slightly bitter, but possess no remarkable properties. Decoction of *veronica officinalis* is recommended as a substitute for tea. The *scrophulariæ* are generally bitter, acrid, and nauseating, producing purging and vomiting. *Digitalis* diminishes the force of the circulation, increases the secretion of the saliva and urine, and may produce vomiting, dejection, vertigo, and death.

SOLANEÆ, Jussieu. In this family are found herbaceous plants, shrubs, and even small trees, sometimes furnished with prickles on several of their parts, having simple or compound leaves, which are alternate, or sometimes geminate towards the upper part of the twigs. Their flowers, which are often very large, are either extra-axillar, or form spikes or racemes. Their monosepalous, persistent calyx, has five shallow divisions. The corolla, which is monopetalous, and in most cases regular, presents very diversified forms, with five more or less plicate lobes. The stamina, which are equal in number to the lobes of the corolla, have their filaments free, rarely monadelphous at the base. The ovary is seated on a hypogynous disk, and has commonly two, rarely three or four polyspermous cells, the ovules of which are attached at the inner angle. The style is simple, terminated by a two-lobed stigma. The fruit is either a capsule, with two or four polyspermous cells, opening by two or four valves, or a two-celled or three-celled berry. The seeds, sometimes reniform, and having a granulated episperm, have a more or less curved embryo, in a fleshy endosperm.

The solaneæ are very intimately allied to the scrophularinæ, but differ from them in having their leaves generally alternate, their corolla regular, their stamina of the same number as the lobes of the corolla, and especially in having their embryo curved upon itself. The last mentioned character is sometimes the only one which equally distinguishes the solaneæ with irregular corollas from certain scrophularinæ. The genera of this family form two sections, according as the fruit is fleshy or capsular.

1. Fruit capsular: *nicotiana, verbascum, hyoscyamus, datura*, &c.

2. Fruit fleshy: *solanum, atropa, capsicum, physalis, lycium*, &c.

The plants of this family may be considered generally as narcotic or poisonous. The properties of tobacco are well known. The leaves of hyoscyamus, datura, and atropa, produce nausea and vertigo. *Datura stramonium* has been employed in epilepsy and asthma. The juice of *atropa belladonna*, besides its general effects, dilates the pupil. The *verbascums*, again, are mucilaginous and mild. *Solanum dulcamara*, a poisonous or narcotic plant, belongs to the same genus as the potato, the root and berry of which have no narcotic effect even when eaten raw, and of which the former is one of our most wholesome esculents. The fruits of *solanum esculentum*, and other species, are also eaten.

ACANTHACEÆ, Jussieu. The acanthaceæ are herbs or shrubs, with opposite leaves, flowers disposed in spikes, and accompanied with bracteas at their base. Their calyx is monosepalous, with four or five divisions, regular or irregular. The corolla is monopetalous, irregular, commonly bilabiate. The stamina are two or four, in the latter case tetradynamous. The ovary has two cells, which contain two or a greater number of ovules, and is applied upon an annular hypogynous disk. The style is simple, terminated by a two-lobed stigma. The fruit is a capsule, with two cells, which are sometimes monospermous, and opens elastically into two valves, each of which carries with it half of the dissepiment. The seeds are generally supported upon a filiform podosperm, and their embryo, which is placed immediately under their proper integument, is destitute of endosperm, and has its radicle generally turned towards the hilum.

This family differs from the scrophularineæ in having its seeds supported upon a long podosperm, in having its embryo destitute of endosperm, as in *justicia, ruellia, thunbergia*, &c. The species are generally bitter and tonic, but their properties are little known.

JASMINEÆ, Jussieu. *Jasmineæ* and *Liliaceæ* Ventenat. *Oleinæ*, Link. This family is composed of shrubs, small trees, or even trees of very large size, with opposite, rarely alternate, simple, or pinnate leaves. The flowers are hermaphrodite, excepting in the genus *fraxinus*, in which they are alternate. The calyx is monosepalous, turbinate in its lower part. The corolla is monopetalous, often tubular and irregular, with four or five lobes, which are sometimes so deep that the corolla seems polypetalous as in *ornus, chionanthus*. It is sometimes entirely wanting. The stamina are only two. The ovary has two cells, each containing two suspended ovules. The style is simple, and terminated by a two-lobed stigma. The fruit is sometimes a two-celled capsule, indehiscent, or opening by two valves; sometimes it is fleshy, and contains an osseous nucleus. The proper integument of the seed is thin or fleshy. The endosperm is fleshy or hard, and contains an embryo having the same direction as the seed.

The genera of this family may be divided into two sections.

1. Fruit dry, LILACEÆ: *lilas, fontanesia, fraxinus, nyctanthes*.

2. Fruit fleshy, JASMINEÆ: *jasminum, olea, ligustrum, philyrea*, &c.

Manna is the concrete juice of several species of *fraxinus*. The flowers of several species of *jasminum* yield a fragrant essential oil used as a

perfume. Olive-oil is obtained from the pericarps of the common olive. The flowers of *olea fragrans* are used by the Chinese in flavouring tea.

Verbenaceæ, Jussieu. The verbenaceæ are trees or shrubs, rarely herbaceous plants, usually with opposite, sometimes compound leaves. The flowers are disposed in spikes or corymbs: more rarely they are axillar and solitary. Their calyx is monosepalous, persistent, and tubular. The corolla is monopetalous, tubular, commonly irregular. The stamina are didynamous, sometimes only two in number. The ovary has two or four cells, containing one or two erect ovules. The style is terminated by a simple or bifid stigma. The fruit is a berry or drupe, containing a nut with two or four cells, which are often monospermous. The seed is composed of a proper integument, and a thin and fleshy endosperm, which covers a straight embryo.

This family, which is composed of the genera *verbena*, *vitex*, *clerodendrum*, *zapania*, &c., is distinguished from the preceding by its fruit being fleshy (excepting in *verbena*), and by its seeds being usually solitary in each cell. Many of the species are mere weeds. Others are esteemed for their showy flowers. *Tectona* furnishes the Indian teak wood so much employed in ship building.

Myoporineæ, Brown. Shrubs generally glabrous, with simple, alternate, or opposite leaves, and axillar flowers, destitute of bracteas. Their calyx is persistent, with five deep divisions. Corolla monopetalous, nearly regular, or slightly two-lipped. The stamina are didynamous or sometimes five in number, one occasionally rudimentary. The ovary is free, applied upon a hypogynous and annular disk. It has from two to four cells, containing each one or two ovules hanging from its summit. The simple style is terminated by a simple stigma. The fruit is a drupe, containing a nucleus with two or four cells, each containing one or two seeds, composed of a cylindrical embryo, placed in the centre of a rather dense endosperm.

The myoporineæ are allied to verbenaceæ, from which they differ, especially in having their seeds pendent, and furnished with a thick endosperm. The family consists of the genera *myoporum*, *bontia*, *pholidia*, *stenochilus*, and *eremophila*. They are all natives of New Holland. The avecennias grow on the shores and among water, something like the mangrove.

Labiatæ, Jussieu. The Labiatæ form one of the most natural families in the vegetable kingdom. They are herbaceous plants, or sometimes shrubs, of which the stem is square, the leaves simple and opposite, the flowers grouped in the axillæ of the leaves, and thus forming spikes or branched racemes. Their calyx is monosepalous, tubular and irregular, and is divided into two lips, an upper and a lower. The stamina are four in number, and didynamous: sometimes the two shorter are abortive. The ovary, which is applied upon a hypogynous disk, is deeply four-lobed, and much depressed at its centre, from which springs a simple style, surmounted by a bifid stigma. A transverse section of the ovary presents four cells, containing each an erect ovule. The fruit is composed of four monospermous akenia, enclosed by the persistent calyx. The seed contains an erect embryo in the centre of a fleshy endosperm, which is sometimes very thin.

The very numerous genera of this family may be divided into two sections, according as they have two or four stamina.

Sect. I. Two stamina: *salvia*, *rosmarinus*, *monarda*, *lycopus*, &c.

Sect. II. Four didynamous stamina: *betonica*, *leonurus*, *thymus*, *ballota*, *marrubium*, *phlomis*, *satureja*, &c.

The plants of this family contain an aromatic volatile oil, camphor, and a bitter extractive, which render them stomachic, stimulant, and tonic. No poisonous or deleterious species has been found amongst them. The roots of *stachys palustris* are eatable. Many species are used as aromatics in food, such as mint, marjoram, and basil. From others agreeable perfumes are extracted, as thyme, lavender, mint, and rosemary.

Boragineæ, Jussieu. The boragineæ are herbs, shrubs, or even sometimes tall trees, bearing alternate leaves, often covered, as well as the stems, with very stiff hairs. Their flowers form unilateral spikes, rolled in the form of a crosier at their summit, often aggregated, and forming a kind of panicle. Their calyx is monosepalous, regular, persistent, and five-lobed. The corolla is monopetalous, regular, five-lobed, and in a certain number of genera presents, near the throat, five projecting appendages, which are hollow within, and open externally at their base. The five stamina are inserted at the upper part of the tube of the calyx, and alternate with the appendages just mentioned, when these are present. The ovary, which is supported upon a hypogynous, annular and sinuous disk, is deeply four-lobed, with four monospermous cells, and deeply depressed at its centre. The style springs from this depression, and is terminated by a two-lobed stigma. The fruit is composed of four monospermous carpels, which are more rarely united, and form a dry or fleshy fruit, with two or four cells, which are sometimes osseous, or with only one cell through abortion. The seeds have their embryo reversed in a fleshy but very thin endosperm, which is sometimes wanting.

The family of boragineæ is related to the labiatæ in the structure of its pistil, which is the

same, and to the scrophularinæ. But it is distinguished from the former by its cylindrical stem, alternate leaves, regular corolla, stamina five in number, and from the latter by the structure of its ovary and fruit.

Among the genera are the following.

Sect. I. Genera without appendages to the corolla: *echium*, *lithospermum*, *pulmonaria*, *onosma*, *cordia*, &c.

Sect. II. Genera furnished with appendages: *symphytum*, *lycopsis*, *anchusa*, *borago*, *cynoglossum*, &c.

Ventenat proposed separating from the boragineæ the genus *cordia*, on account of its simple and fleshy fruit, and forming of it a family under the name of *sebestenæ*. Mr Brown thinks that the genera *hydrophyllum*, *ellisia*, and *phacelia*, which have a capsular fruit, a large horny endosperm, and compound or deeply-lobed leaves, form a distinct family, which he names *hydrophyllæ*. Lastly, Professor Schrader, in his excellent memoir on the boragineæ, proposes to divide them into three distinct orders: *borageneæ*, *hydrophylleæ*, and *heliotropiceæ*.

The plants of this family are common in Europe, and the north of Africa, less abundant in India, and the equatorial regions, and not unfrequent in New Holland; they are mucilaginous and emollient, but possess no properties that qualify them to be of much importance as food or medicine; many species are mere weeds, others are beautiful ornamental flowers. The roots of *anchusa tinctoria*, *lithospermum tinctorium*, *anchusa virginica*, and some other species, are used to dye a red colour. Pure nitre has been found in several species.

Convolvulaceæ, Jussieu. Herbaceous or suffrutescent plants, often voluble and climbing, having alternate leaves, which are simple, or more or less deeply lobed; axillar or terminal flowers; a monosepalous, persistent calyx, with five divisions; a monopetalous, regular corolla, with five plicate lobes; and five stamina inserted into the tube of the corolla. The ovary is simple and free, supported upon a hypogynous disk, and has from two to four cells containing a small number of ovules. The style is simple or double. The fruit is a capsule having from one to four cells, usually containing one or two seeds, attached towards the base of the dissepiments. It opens into two or four valves, the edges of which are applied upon the dissepiments which remain in place. More rarely the capsule remains closed, or opens into two superimposed valves. The embryo, of which the cotyledons are flat and plicate, is rolled upon itself, and placed in the centre of a soft and as it were mucilaginous endosperm.

The essential character of this family consists in its capsule, the sutures of which correspond to the dissepiments. This character being wanting in some genera formerly united with the convolvulaceæ, such as *hydrolea*, *nama*, *sagonca*, and *diapensia*, Mr Brown has proposed forming them into a distinct family under the name of *hydroleaceæ*. The principal genera of the convolvulaceæ are *convolvulus*, *ipomæa*, *cuscuta*, *evolvulus*, *cressa*, &c.

The roots are generally acrid and purgative. Jalap is obtained from *convolvulus jalapa*, and scammony from *c. scammonia*. The root of *c. panduratus* is used as a purgative in North America, and those of many other species possess the same properties. On the other hand, those of the sweet potato *(c. batatas)* and *edulis* are articles of food. Several species are garden flowers.

Polemoniaceæ, Jussieu. Herbaceous or woody, sometimes twining plants, furnished with alternate or opposite leaves, often divided and pinnatifid, and axillar or terminal flowers, forming branched racemes. Each flower is composed of a five-lobed, monosepalous calyx; a regular, seldom irregular, monopetalous corolla, with five more or less deep divisions; five stamina inserted into the corolla; an ovary applied upon a disk which is often spread out at the bottom of the flower and lobed. This ovary has three cells, containing one, or more frequently several ovules. The style is simple, terminated by a trifid stigma. The fruit is a three-celled capsule, opening by three valves, which are septiferous on the middle of their inner face, or only bear the impression of the dissepiment, which remains untouched at the centre of the capsule. The seeds have an erect embryo in the centre of a fleshy endosperm.

This family is in some measure intermediate between the convolvulaceæ and bignoniaceæ. It differs from the former in having its valves septiferous in the middle of their inner surface, and not contiguous at their margins over the dissepiments, and in its erect embryo; from the latter, in having the corolla almost always regular, the ovary three-celled, its valves septiferous, &c. The genera which compose this family are in small number: *polemonium*, *phlox*, *cantua*, *bonplandia*, and probably *cobæa*. They are natives of the mountainous parts of Europe. Some are showy plants but possess no remarkable properties.

Bignoniaceæ, Jussieu. *Bignoniaceæ*, and *Pedalineæ*, Brown. Trees, shrubs, or more rarely herbaceous plants, with the stem often sarmentose and furnished with cirri. The leaves are commonly opposite or ternate, rarely alternate, usually compound. The flowers, which are terminal, or axillar, and variously grouped, have a monosepalous, often persistent, five-lobed calyx, a monopetalous corolla, more or less irregular, and with five divisions. The stamina are commonly four and didynamous, accompanied

by a sterile filament, which is the indication of a fifth abortive stamen. In some genera the five stamina are equal, or two only are fertile. The ovary, which is placed upon a hypogynous disk, presents one or two cells usually containing several ovules. The style is simple and terminated by a bilamellate stigma. The fruit is a capsule with one or two cells, opening by two valves opposite to the dissepiment. In some rare cases the fruit is fleshy, or hard and indehiscent. The seeds, which are often margined with a membranous wing all round, contain beneath their proper integument an erect embryo, destitute of endosperm.

The principal genera of this family are *bignonia, catalpa, jacaranda, tecoma*, &c., of which the seeds are winged; and *sesamum, martynia*, and *craniolaria*, of which the seeds are wingless. They are generally tropical plants and have showy ornamental flowers. *Bignonia radicans* is a beautiful climbing plant, and the *jacarandas* have large blue and purple flowers, with elegant leaves. Their wood is said to resist the attacks of worms.

Gentianeæ, Jussieu. Nearly all the gentianæ are herbaceous plants, rarely frutescent, bearing smooth, entire, opposite leaves. Flowers solitary, terminal or axillar, or collected into simple spikes. Calyx monosepalous, often persistent, with five divisions. Corolla monopetalous, regular, commonly with five lobes, which are imbricated previous to their development. The stamina are of the same number as the divisions of the corolla, and alternate with them. The ovary, sometimes contracted and in a manner fusiform at its base, has a single cell, containing a great number of ovules attached to two parietal and sutural trophosperms, bifid on the inner side. The style is simple and deeply bipartite; each division bearing a stigma. The fruit is a one-celled capsule, containing a very great number of seeds. It opens by two valves, the edges of which are more or less inflected to meet the trophosperms. The seeds are generally very small, and their embryo, which is erect, is contained in the axis of a fleshy endosperm.

This family is well characterized by its general appearance, its opposite entire leaves, and their glaucous green colour. It is allied, on the one hand, to the proteaceæ, from which it differs in its opposite leaves, its two-celled ovaries, and the peculiar mode of dehiscence of its capsule; and, on the other hand, to the scrophularineæ, which, however, are easily distinguished by their irregular corolla, their four didynamous stamina, and the dehiscence of their fruit. Of the genera of this family we may mention *gentiana, erythræa, chironia, exacum, villarsia*, and *menyanthes*. The two last are remarkable for their alternate leaves, which are ternate in *menyanthes*.

They are all pretty plants, but are finer in their wild state than when cultivated. In their properties they are generally bitter, stomachic, and tonic. The roots of *gentiana lutea, purpurea, rubra*, and *amarilla*, are employed as such. *Menyanthes trifoliata* is also intensely bitter, as is *villarsia nymphoides*. *Erythræa centaurium* and *latifolia* yield an intense bitter, less nauseous than that of most others.

Apocyneæ, Jussieu. *Apocyneæ* and *Asclepiadeæ*, Jussieu. *Strychneæ*, Jussieu. The apocyneæ are very different in their aspect. They are herbaceous plants, shrubs, or even tall trees, and generally lactescent. Their leaves are simple and opposite. Flowers axillar or terminal, solitary or variously aggregated. The calyx monosepalous, with five divisions, sometimes spreading, sometimes tubular. Corolla monopetalous, regular, of very diversified form, sometimes presenting five concave, petaloid appendages, which spring from the throat of the corolla, and are in part united to the stamina, which are five in number, sometimes free and distinct, sometimes united by the filaments and anthers, and forming a kind of tube which covers the pistil, and is often united at its summit to the stigma. The anthers are two-celled, and the pollen which they contain is pulverulent in those whose stamina are free, and in solid masses of the same form as the interior of the cell in those in which the stamina are united. Each pollen-mass is terminated at its summit by a gland, which is united to that of the pollen-mass next to it. Two free ovaries, applied upon a hypogynous disk, united together by their inner side or only by their summit, present each a cell which contains a great number of ovules placed at their inner suture. The two styles are sometimes united into one, and terminate in a more or less discoid, sometimes cylindrical and truncate stigma. The fruit is a simple or double follicle; more rarely it is fleshy and indehiscent. The seeds, which are attached to a sutural trophosperm, are naked or crowned by a pappus. They contain in a fleshy or horny endosperm a straight embryo.

This family has been divided by Mr Brown into two:

1. The true Apocyneæ, which have the corolla destitute of appendages, and the pollen powdery. Such are the genera *apocynum, vinca, rauwolfia, arduinia, nerium*, &c.

2. The Asclepiadeæ, the corolla of which is furnished with an appendage, and the pollen in solid masses, as in the orchideæ. Such are the genera *asclepias, hoya, cynanchum*, &c.

Their properties are acrid, stimulating, or narcotic, frequently highly poisonous. Nux vomica is the seed of a species of *strychnos* of that name. The seed of *cerbera tanghin* is a violent poison, as is that of many other species.

Many of these plants, however, are employed as purgatives, diaphoretics, tonics, and febrifuges, and others as articles of food. It is probable that when their properties are better known, they will be found to be of eminent service in medicine and domestic economy.

SAPOTEÆ, Jussieu. Trees or shrubs all extra-European and for the most part inter-tropical. Their leaves are alternate, entire, persistent, and coriaceous; their flowers hermaphrodite and axillar. Calyx persistent, monosepalous. Corolla monopetalous, regular, with lobes equal in number to those of the calyx, double or triple. The stamina are in definite number: some of them, of the same number as the lobes of the calyx, and opposite to the petals, are fertile; the rest, alternate with the others, sterile. The ovary has several cells, containing each an erect ovule. The style is terminated by a generally simple, sometimes lobed stigma. The fruit is fleshy, with one or several monospermous, sometimes bony cells. The embryo is erect, and is contained in a fleshy endosperm, which is rarely wanting.

The genera of this family are *achras, mimusops, syderoxylon, imbricaria, lacuma*, &c. It is closely allied to the ebenaceæ, which differ from it in having their flowers generally unisexual, their stamina disposed in two series, their style divided, and their seeds pendent.

The fruits of some species contain a thick oil used for domestic purposes. Those of others are sweet and used as food. To this family the famous cow-tree of India is supposed to belong.

MYRSINEÆ, Brown. *Ardisiaceæ*, Jussieu. *Ophiospermiæ*, Ventenat. The myrsineæ are trees or shrubs, with alternate, very rarely opposite or ternate leaves, which are glabrous, coriaceous, entire or toothed, and destitute of stipules. The flowers are disposed in racemes or a kind of umbels, or are simply grouped in the axilla of the leaves, or at the summit of the twigs. They are hermaphrodite, rarely unisexual. Their calyx is generally persistent, with four or five deep divisions. Their corolla is monopetalous, regular, with four or five lobes. The stamina, equal in number to the lobes of the corolla, and sometimes monadelphous, are attached to the base of the lobes, and are opposite to them. The filaments are short, the anthers sagittate. The ovary is free, unilocular, containing a variable number of ovules inserted upon a central trophosperm, in which they are sometimes more or less deeply immersed. The style is simple, terminated by a simple or lobed stigma. The fruit is a kind of dry drupe, or a berry containing from one to four seeds. The seeds are peltate, with their hilum concave; their simple integument covering a fleshy or horny endosperm, in which is contained a cylindrical embryo, little curved, and placed transversely to the hilum.

This family is closely related to the sapoteæ and ebenaceæ, in its general aspect, and in several of its characters. On the other hand, the structure of its ovary, and the circumstance of the stamina being opposite to the lobes of the corolla, give it some affinity to the primulaceæ. The genera which compose the family of myrsineæ are the following: *myrsine, ardisia, jacquinia, samara, wallenia*, and *ægicera*. These species are natives of tropical climates, and are showy plants in the greenhouse and stove.

EBENACEÆ, Rich. *Guyacaneæ*, Jussieu. This family is composed of trees or shrubs, which are not lactescent, and of which the wood is very hard, and often of a dark colour in the centre. Their leaves are alternate, entire, often ceriaceous, and shining. The flowers are generally axillar, rarely hermaphrodite, most commonly polygamous. Their calyx is monosepalous, with three or six equal and persistent divisions. The corolla is regular, monopetalous, its limb with three or six imbricated divisions. The stamina are in definite number, sometimes inserted upon the corolla, sometimes immediately hypogynous. They are in double or quadruple the number of the divisions of the corolla, very rarely in equal number, and then alternating with them. Most commonly the stamina are disposed in two rows, and have their anthers linear-lanceolate, and two-celled. The ovary is free, sessile, with several cells containing each one or two pendent ovules. The style is divided, more rarely simple; the stigmas are simple or bifid. The fruit is a globular berry, sometimes opening in a nearly regular manner, and containing a small number of compressed seeds. Their tegument covers a cartilaginous endosperm, in which is an embryo having the same direction as the seed.

As now limited, the family of ebenaceæ is composed of the genera *diospyros, royena, paralea*, &c. It is related to the sapoteæ, but these have their stamina of the same number as the divisions of the corolla, to which they are opposite, and besides, present several other distinctive characters.

Diospyros virginiana affords fruits which are eatable when perfectly ripe; but the family, in general, is remarkable only for the hardness of the wood which it affords.

STYRACEÆ, Rich. *Symploceæ*, Jussieu. This little family contains trees or shrubs with alternate leaves, destitute of stipules, and axillar, sometimes terminal flowers. The calyx is free, or adherent to the inferior ovary, its limb entire or divided. The corolla is monopetalous and regular. The stamina, which vary from six to sixteen, are free or monadelphous at their base. The ovary is sometimes superior, sometimes inferior, commonly with four cells, separated by

very thin, membranous dissepiments. Each of these cells commonly contains four ovules attached to the inner angle of the cell, and of which two are erect, two reversed. The style is simple, terminated by a very small simple stigma. The fruit is slightly fleshy. It contains from one to four bony and more or less irregular nucules. The seed is formed of a proper integument, and a fleshy endosperm, which contains a cylindrical embryo, having the same direction as the seed.

This family is composed of only a few genera, *halesia, symplocos, styrax, alstonia*, and *ciponima*. It differs from the ebenaceæ in having a perigynous insertion, a quadrilocular ovary with four ovules, two erect and two reversed, and a simple style.

The gum resins storax and benzoin are obtained from *styrax officinalis* and *benzoin*.

Ericineæ. This family consists of shrubs and small trees, of elegant forms, having in general simple, alternate leaves, rarely opposite, verticillate or very small, and in the form of imbricated scales. Their inflorescence is very variable. The monosepalous calyx is sometimes free, sometimes adherent to the ovary, which is then inferior, with five divisions, which are sometimes so deep, that it appears formed of distinct sepals. The corolla is monopetalous, regular, with four or five lobes, sometimes with four or five distinct petals. The stamina, which are generally double the number of the divisions of the corolla, have their filaments free, rarely connected at their base. The anthers are introrse, one-celled or two-celled, sometimes terminated by two horn-shaped appendages at their summit or base, and generally opening by a hole near their summit. These stamina are generally attached to the corolla; but sometimes they are immediately hypogynous. The ovary is inferior or free; in the latter case, it is sessile at the bottom of the flower, or applied upon a hypogynous disk, which is more or less prominent, and sometimes has the form of lobes or scales. It has from three to five cells, each containing a considerable number of ovules attached at their inner angle. The style is simple, terminated by a stigma having as many lobes as the ovary has cells. The fruit is a berry, or more commonly a capsule, sometimes crowned by the limb of the calyx, and opening by as many valves as there are cells. Sometimes each of these valves carries with it one of the dissepiments on the middle of its inner face and sometimes the dehiscence takes place opposite each dissepiment. The seeds are composed of a fleshy endosperm, in the middle of which is an axile, cylindrical embryo, having the same direction as the seed.

The rhodoraceæ of Jussieu differ from the ericineæ only in their capsule, the valves of which carry with them the dissepiments on the middle of their inner surface, whereas in the ericineæ in general the dehiscence takes place opposite the dissepiments. This family is divided into

1. Vacciniæ: ovary inferior. *Vaccinium, escallonia, gaylussaccia*, &c.

2. Ericineæ: ovary free, disk hypogynous, anthers bilocular. *Erica, rhododendron, rhodora, ledum, clethra, arbutus, andromeda*, &c.

3. Epacrideæ: ovary free, disk in the form of five hypogynous scales, anthers unilocular. *Epacris, styphelia, leucopogon*, &c.

The berries of the vacciniæ are generally eatable. The bark and leaves are slightly astringent. The ericæ are astringent and diuretic. The *rhododendra* and *azaleæ* are acrid and poisonous. All the species are ornamental plants.

Gessneriaceæ, Rich. These are herbaceous plants, rarely shrubby at their base, bearing opposite or alternate leaves, and axillar or terminal flowers. The calyx is monosepalous, persistent, with five divisions, adhering by its base to the ovary, which is generally inferior. The corolla is monopetalous, irregular, with five unequal lobes sometimes forming two lips. The stamina are two or four, inserted upon the corolla. The ovary is either inferior or free: in the former case, it is crowned by an epigynous often lobed disk; in the latter case, the disk is hypogynous and often lateral. The style is simple, terminated by a simple stigma, concave in its centre. The ovary has a single cell in which the numerous ovules are attached to two parietal trophosperms, branched on the side of the cell. The fruit is either fleshy or dry, and forms a unilocular capsule opening by two valves.

Campanulaceæ, Jussieu. The Campanulaceæ are commonly herbaceous or shrubby plants, generally abounding in a white and bitter juice. Their leaves are alternate and entire, rarely opposite. Their flowers form spikes, thyrsi, or capitula. They have a monosepalous calyx, with four, five, or eight persistent divisions, and a regular or irregular monopetalous bell-shaped corolla, having its limb divided into as many lobes as there are divisions to the calyx, sometimes as if two-lipped. The stamina, five in number, are alternate with the lobes of the corolla. Their anthers are free, or brought together in the form of a tube. The ovary is inferior or semi-inferior, with two or more polyspermous cells. The style is simple, terminated by a lobed stigma, sometimes surrounded by hairs or a kind of cupuliform cavity. The fruit is a capsule crowned by the limb of the calyx, with two or more cells, opening either by means of holes which are formed near the upper part, or by incomplete valves, which carry along with them part of the dissepiments on the middle of their inner surface. The seeds, which are very small and very numerous, contain an axile and erect embryo in a fleshy endosperm.

This family is divided into—

1. CAMPANULACEÆ.—Corolla regular, stamina distinct, capsule with two polyspermous cells, as *campanula, phyteuma, prismatocarpus, jasione,* &c.

2. LOBELIACEÆ, Rich.—Corolla irregular, stamina united by the anthers, stigma surrounded by hairs, as *lobelia, lysipomia,* &c.

3. GOODENOVIEÆ, Brown.—Corolla irregular, stamina free or united by the anthers, stigma surrounded by a kind of cup, a bilocular capsule, or a monospermous nut, as *goodenovia, euthales, lechenaultia,* &c.

4. STYLIDIEÆ, Brown.—Corolla irregular; two stamina, of which the filaments are confounded with the style, and form a kind of central column; stigma situated between the two anthers; capsule bilocular, bivalve, as *stylidium, leuwenhoekia,* &c.

The roots and young shoots of *campanula rapunculus* and *phyteuma spicata,* are eaten. The lobeliaceæ are acrid and frequently poisonous. *Lobelia inflata* is a powerful emetic and diaphoretic, but produces great debility. *Lobelia longiflora* is extremely violent in its operation. The properties of many are unknown. Several of the genera are ornamental flowers.

SYNANTHEREÆ, Rich. *Cichoraceæ, corymbiferæ,* and *cynarocephalæ,* Jussieu. *Compositæ* of Authors. This great family is one of the best defined and best characterized in the vegetable kingdom. It comprehends herbaceous plants, shrubs, or even small trees. Their leaves are commonly alternate, rarely opposite. Their flowers, which are generally small, form capitula or calathidia, which are hemispherical, globular, or more or less elongated. Each capitulum is composed: 1st, Of a common receptacle, thick and sometimes fleshy, convex or concave, which has received the names of *phoranthium* and *clinanthium;* 2dly, Of a common involucre which surrounds the capitulum, and is composed of scales, the form, number, and disposition of which vary in the different genera; 3dly, Of small scales or hairs, which are frequently found on the receptacle at the base of each flower. The flowers which form the capitula are of two kinds: some present a regular, monopetalous funnel-shaped corolla, generally with five regular lobes, and are named *florets, flosculi;* others have an irregular corolla, thrown to one side in the form of a strap, and are named *semiflorets, semiflosculi.* Sometimes the capitula are composed exclusively of florets, sometimes exclusively of semiflorets, and sometimes their centre is occupied by florets, and their circumference by semiflorets. Each flower presents the following organization: The calyx, which is adherent to the ovary, has its limb entire, membranous, toothed, and formed of scales or hairs; the corolla monopetalous, regular or irregular; five stamina with distinct filaments, but with the anthers united, and forming a tube through which passes a simple style, terminated by a bifid stigma. The fruit is an akenium, naked at its summit, or crowned by a membranous margin, small scales, or a tuft of simple or feathery hairs, which is sessile or stipitate. The seed is erect, containing a homotrope embryo, without endosperm.

This family, which has much engaged the attention of botanists, may be divided into three principal tribes.

1. The CYNAROCEPHALÆ, of which all the flowers are *flosculi,* and which have their receptacle furnished with numerous hairs or alveolæ, the style enlarged, and furnished with hairs under the stigma. Such are the genera *carthamus, carduus, cynara, centaurea, onopordum,* &c.

2. The CICHORACEÆ, of which all the flowers are *semiflosculi.* Such are the genera *lactuca, cichorium, sonchus, hieracium, prenanthes,* &c.

3. The CORYMBIFERÆ, of which the capitula are generally composed of *flosculi* at the centre, and *semiflosculi* at the circumference, as *helianthus, chrysanthemum, anthemis, matricaria,* &c.

The synanthereæ are generally bitter, and more or less stimulant and tonic. The cinarocephalæ abound in bitter extractive, and many of them have consequently been used as stomachics and tonics; such as *carduus benedictus, c. marianus,* &c. *Arctium lappa* is diaphoretic and diuretic. The young leaves possess little bitterness, and may be used as salad. The seeds are oily and aperient. The cichoraceæ have a milky, bitter, narcotic juice, which, when inspissated, resembles opium in its action. *Lactuca virosa* and *sylvestris,* and *cichorium intybus,* are more especially remarkable for this narcotic juice. Cultivation deprives these plants of their bitter quality, and renders them eatable, as is the case with the common lettuce. Others, by being blanched, are rendered palatable, and are common articles of food. The corymbiferæ resemble the cynarocephalæ in their properties. *Tussilago farfara, eupatorium perfoliatum, inula helenium,* and common chamomile, are stomachic, stimulant, and tonic. They contain a resinous principle combined with bitter extractive. Others, in which the resinous matter predominates, are used as anthelmintics and emenagogues, as *artemisia, tanacetum,* and *santolina.*

CALYCEREÆ, Rich. Herbaceous plants, bearing a considerable resemblance to the scabiosæ in their general aspect. Their stem bears alternate leaves, often divided and pinnatifid. The flowers are small, and form globular capitula, surrounded by a common involucre. The receptacle which bears the flowers is furnished with foliaceous scales, which are sometimes united to the flowers, so as not to be distinct from them. The calyx is adherent to the inferior ovary, and

the divisions of its limb are sometimes rigid and spinous. The corolla is monopetalous, tubular, infundibuliform, and regular; beneath the five stamina are five nectariferous glands. These stamina are connected both by their filaments and anthers, and form a cylindrical tube, each anther opening by its inner surface. The inferior ovary has a single cell, from the summit of which hangs a reversed ovule. The summit of the ovary presents an epigynous disk, and a simple style terminated by a hemispherical stigma. In the genus acicarpha, all the flowers are united together by their ovaries. The fruit is an akenium crowned by the spinous teeth of the calyx. The seed presents beneath its proper integument an endosperm, containing an embryo which is reversed like the seed.

Dipsaceæ, De Candolle. Stem herbaceous; leaves opposite, without stipules; flowers collected into hemispherical or globular capitula, accompanied at their base by an involucre of several leaflets. The calyx is double; the outer monopetalous, free, entire or divided into narrow, setaceous segments; the inner adherent to the ovary, and terminated by an entire or divided limb. The corolla is monopetalous, tubular, with four or five unequal divisions. The stamina are of the same number as the divisions, and alternate with them. The ovary is inferior, with a single cell, containing a single pendent ovule. The style and stigma are simple. The fruit is an akenium crowned by the limb of the calyx, and enveloped in the outer calyx. The seed is pendent, and its embryo, which has the same direction, is placed in a rather thin fleshy endosperm.

De Candolle has removed from this family such as Jussieu left it, the genus *valeriana*, and some others, to form of them the family of valerianeæ, which differs from the true dipsaceæ, in not having the flowers collected into capitula, in its simple calyx, its lobed stigma, &c.

In their general aspect, and especially in their inflorescence, the dipsaceæ have some resemblance to the synanthereæ, but they differ from them in having the calyx double, the anthers free, and the seed reversed. The principal genera of this family are: *dipsacus*, *scabiosa*, and *knautia*.

The root of *scabiosa succisa* is astringent.

Valerianeæ, De Candolle. Herbaceous plants, with opposite, simple, or more or less deeply incised leaves, and flowers destitute of a calyculus, usually disposed in terminal clusters or panicles. Their calyx is simple, adherent to the ovary, and having its limb toothed or involute, and forming an entire margin. The corolla is monopetalous, more or less irregular, and sometimes spurred at its base, and five-lobed. The stamina vary from one to five, and are alternate with the lobes of the corolla. The ovary is one-celled: sometimes there are two other empty cavities or false cells, so that the ovary seems trilocular. The cell contains a single pendent ovule. The style is simple, commonly terminated by a trifid stigma. The fruit is an akenium, crowned by the teeth of the calyx, or by a feathery pappus, formed by the unrolling of the limb. The seed contains an embryo destitute of endosperm.

This family is composed of the genera *valeriana*, *centranthus*, *fedia*, *patrinia*, and others.

The root of *valeriana officinalis* is bitter, aromatic, and antispasmodic, as are those of some other species. The leaves of fedia are eaten as salad.

Rubiaceæ, Jussieu. Opercularieæ, Jussieu. Herbaceous plants, shrubs, and large trees. Their leaves are either opposite or verticillate: in the first case, they have on each side an intrapetiolar stipule, which is often united to the sides of the petiole, and forms a kind of sheath. The flowers are axillar or terminal, sometimes collected into a capitulum. The calyx, which adheres by its base to the inferior ovary, has its limb entire or divided into four or five more or less deep and persistent lobes. The corolla is monopetalous, regular, epigynous, with four or five lobes. The stamina are of the same number as the lobes of the corolla, and alternate with them. The ovary is inferior, surmounted by a simple or bifid style. It has two, four, five, or a greater number of cells, containing each one or more ovules, which are erect or attached to the inner angle of the cell. The fruit varies greatly. Sometimes it is composed of two small monospermous and indehiscent cocca; sometimes it is fleshy, and contains two monospermous nuclei; in certain genera it is a capsule, with two or a greater number of cells, opening by as many valves; or a fleshy and indehiscent fruit. The fruit is always crowned at its summit by the limb of the calyx. The seeds, sometimes winged and membranous on their margin, contain, in a hard and horny endosperm, an axile embryo, which is erect, or sometimes placed transversely with respect to the hilum.

This family is divided into two principal sections. In one are placed all the genera with verticillate leaves, such as *galium*, *asperula*, *rubia*, *sherardia*, *crucianella*, &c.; in the other the much more numerous genera, which have the leaves opposite and the stipules intermediate, as *cinchona*, *coffea*, *cephaelis*, *psychotria*, &c.

The roots of *rubia tinctorum*, *galium verum*, and other species, afford a red dye. The seeds of *galium aparine* have been recommended as a substitute for coffee. The plants of the second section are remarkable for their powerful tonic or emetic qualities. The tonic and febrifuge properties of the bark of the cinchonæ, depend upon the presence of two alkalies, cinchonia and quinin, which are combined with kinic acid.

Ipecacuan is the root of *cephaelis ipecacuanha*. Several species of *psychotria* possess similar properties. Coffee is the seed of *coffea arabica*.

Caprifoliaceæ, Rich. Shrubs with opposite, rarely alternate, generally simple, more rarely imparipinnate leaves, without stipules. The flowers are axillar, solitary, or often geminate, and in part united together by their calyx, disposed in cymes, or collected into a kind of capitulum. The calyx is always monosepalous, and is adherent by its lower part to the ovary, which is inferior. The limb has five persistent teeth. The corolla is monopetalous, commonly irregular; sometimes it is formed of five distinct petals. The stamina are five in number, alternating with the divisions of the corolla. The ovary has from one to five cells, each containing either a single pendent ovule, or several ovules attached at its inner angle. The style is simple, terminated by a very small and scarcely lobed stigma. The fruit is sometimes geminate, that is, formed by the union of two ovaries. It is fleshy, with one or two sometimes osseous cells, each containing one or more seeds. The seeds have a proper integument, sometimes covered by a nucleus and a fleshy endosperm, which contains an axile embryo, having the same direction as the seed.

This family may easily be divided into two natural tribes, according as the cells of its ovary are monospermous, or polyspermous.

1. Hederaceæ: cells of the ovary monospermous. *Hedera, cornus, sambucus, viburnum.*

2. Lonicereæ: cells of the ovary polyspermous. *Lonicera, xylosteum, symphoricarpos*, &c.

This family, which is allied to the rubiaceæ, differs from them especially in its irregular corolla, and the absence of stipules between the leaves.

The leaves of *sambucus nigra* are emetic and purgative. Some fruits of the genera *cornus, sambucus*, and *viburnum*, are eatable. The bark of *cornus florida* has been used in intermittent fevers. Many of the genera are ornamental shrubs, or useful as wood.

Loranthеæ, Rich. The loranthеæ are mostly perennial-herbaceous, and generally parasitic plants. Their stem is woody and branched; their leaves simple and opposite, entire or toothed, coriaceous, persistent, and destitute of stipules. The flowers are variously disposed, sometimes solitary, sometimes in axillar or terminal spikes, racemes, or panicles. The flowers are generally hermaphrodite, sometimes diœcious. The calyx is adherent to the inferior ovary; its limb is entire or slightly toothed. It is accompanied externally by two bracteas, or by a second cup-shaped calyx, sometimes entirely enveloping the true one. The corolla is composed of from four to eight petals, inserted towards the summit of the ovary. These petals are occasionally united, so as to represent a monopetalous corolla. The stamina are of the same number as the petals, and opposite to them; the anthers sessile, or supported upon filaments varying in length. The ovary is one-celled, and contains a reversed ovule. It is crowned by an epigynous and anular disk. The style is often long and slender, sometimes entirely wanting; the stigma often simple. The fruit is generally fleshy, containing a single reversed seed, adherent to the pulp of the pericarp, which is thick and viscous. The seed contains a fleshy endosperm, in which is placed a cylindrical embryo, having the radicle directed towards the hilum.

The principal genera are *loranthus, viscum, aucuba*, &c.

The bark is usually astringent. The misseltoe is a well known parasitic plant.

Rhizophoreæ, Brown. Extra-European trees, with opposite, simple leaves, and interpetiolar stipules, as in the rubiaceæ. Their calyx, which is adherent to the ovary, has four or five valvar divisions to its limb, which is persistent. The corolla is composed of four or five petals. The stamina vary from eight to fifteen. The ovary, which sometimes is only semi-inferior, has always two cells, each of which contains two or a great number of pendent ovules. The style is simple, the stigma bipartite. The fruit, which is crowned at its summit by the calyx, is unilocular, monospermous, and indehiscent. The seed which it contains is composed of a large embryo destitute of endosperm. The embryo sometimes germinates and is developed within the fruit, which it perforates at its summit.

The genera *rhizophora, bruguiera*, and *carallia*, are all that compose this family, which differs from the caprifoliaceæ, to which these genera were formerly referred, in having the corolla polypetalous, the fruit coriaceous, and the embryo without endosperm; and from the loranthеæ, in having the embryo destitute of endosperm.

Umbelliferæ, Jussieu. The Umbelliferæ, which form one of the most natural families in the vegetable kingdom, are herbaceous plants, of which the stem is often internally hollow; the leaves are alternate, sheathing at their base, generally decompounded into numerous segments or leaflets. The flowers, which are always very small, white, or yellow, are disposed in umbels. Sometimes there are seen, at the base of the umbel, small leaflets, which collectively constitute the involucre; and, at the base of the umbellules, others which constitute the involucels. Each flower is composed of a calyx, which is adherent to the inferior ovary, and of which the limb is entire, or scarcely toothed; a corolla, formed of five more or less spreading petals; five epigynous stamina, alternating with the petals; an ovary with two cells, each containing a reversed

ovule, and crowned at its summit by an epigynous and two-lobed disk; and two styles, terminated each by a small simple stigma. The fruit is a diakenium of very diversified form, separating, at maturity, into two monospermous akenia, connected by a small filiform columella. The seed is reversed, and contains, in a pretty large endosperm, a very small axile embryo.

The genera of this family are extremely numerous, as *daucus, carum, amni, scandix, apium, pastinaca*, and many others.

The roots of the wild carrot *(daucus carota)*, are aromatic and rather pungent, but eatable. Those of the cultivated carrot, skirret, and parsnip, are used as articles of food. The root of *bunium bulbocastanum* is also eatable; as are the stems of the celery, and *heracleum, sphondyllium*, and the leaves of the parsley. But, in general, the stems and leaves of the plants of this order are nauseous, and often poisonous. Those of *œnanthe crocata, conium maculatum, cicuta virosa*, and *æthusa cynapium*, are of the latter character. The fruits are often agreeably aromatic, as in *carum carui, coriandrum sativum*, &c. Opoponax and asafœtida, are procured from plants of this order, as are galbanum and gum ammoniac. The species which produce aromatic seeds generally grow in dry soil, and those which are most virulent in their properties usually in watery, damp, or shady places.

Araliaceæ, Jussieu. The araliaceæ form a group scarcely distinct from the umbelliferæ. They are herbaceous plants, or sometimes very tall trees. Their flowers, which are also very small, are disposed in simple or paniculate umbels. Their calyx is adherent and toothed, as in the umbelliferæ. Their corolla is formed of five or six petals. Their ovary has from two to six monospermous cells, and is surmounted by as many styles, terminated by simple stigmas. The fruit is sometimes fleshy and indehiscent, sometimes dry, and separating into as many monospermous cocca, as the ovary has cells.

This family is very closely allied to the umbelliferæ, from which it differs in having a greater number of cells and styles, or in having the fruit fleshy, as in *aralia, panax, gastonia*, &c.

Ginseng, a tonic much used by the Chinese, is the root of *panax quinquefolia*.

Ranunculaceæ, Jussieu. This great family is composed of herbaceous plants, bearing alternate leaves, amplexicaul at their base, most commonly divided into numerous segments. The leaves are opposite in the genus *clematis* only. The flowers vary much in their disposition; sometimes they are accompanied with an involucre formed of three leaves, which may be distant from the flower, or placed near it and calyciform. The calyx is polysepalous, often coloured and petaloid, rarely persistent. The corolla is polypetalous, sometimes wanting. The petals are sometimes simple, with a small hollow or a glandular lamina at their inner base; more commonly diversiform, or irregularly hollowed in the shape of a horn, and abruptly unguiculate at their base. The stamina, which are generally numerous, are free, with anthers continuous with the filaments. The pistils are sometimes monospermous, and aggregated into a kind of capitulum, or polyspermous and circularly grouped, and sometimes more or less intimately united. The style is very short, commonly lateral; the stigma simple. The fruits are monospermous, indehiscent, disposed in capitula or spikes: or they are aggregated capsules, which are distinct or united, sometimes solitary, unilocular, polyspermous, opening by their internal suture, which bears the seeds; very rarely the fruit is a polyspermous berry. The seeds are not arillate; the embryo is very small, has the same direction as the seed, and is contained in the base of a fleshy or hard endosperm.

The numerous genera of this family may be divided into two great sections, according as the ovaries are monospermous or polyspermous.

Among the first are, *ranunculus, ficaria, ceratocephalus, myosurus, adonis, anemone, clematis, thalictrum.*

And among the second, *pæonia, caltha, trollius, eranthis, helleborus, nigella, garidella, aquilegia, delphinium, aconitum, actæa.*

These plants are generally acrid and poisonous, and their properties are supposed to depend upon a volatile principle, removed by the application of heat or by drying. The fresh leaves and stems of *ranunculus sceleratus* and *flammula* produce blisters on the skin. The root of *aconitum napellus*, and *pæonia officinalis*, are acrid and bitter. That of several species of *helleborus* is purgative. *Anemone nemorosa* is supposed to produce the disease called red-water in cattle. With the exception of clematis, and xanthoriza which have shrubby stems, all the others are herbaceous. The anemone, ranunculus, and others are esteemed garden flowers.

Dilleniaceæ, De Candolle. This family consists of trees, or shrubs, chiefly natives of tropical countries, having alternate, very rarely opposite leaves, without stipules, often amplexicaul at their base, and solitary or clustered flowers, sometimes opposite to the leaves. Their calyx is persistent, monosepalous, with five deep divisions, laterally imbricated. Their corolla is commonly of five petals. Their stamina are very numerous, free, disposed in several rows, sometimes unilateral and disposed in several bundles. The carpels, which vary from two to twelve, are generally distinct, but sometimes united. Their ovary is unilocular, containing two or more ovules, attached to the lower part of their inner angle, and erect. The styles are simple, and terminated each by a simple stigma. The

fruits are distinct or united, fleshy or dry and dehiscent. The seeds have a crustaceous tegument, covering a fleshy endosperm, in which is a very small erect embryo, placed towards its base.

To this family belong the genera *tetracera, davilla, delima, pachynema, pleurandra, dillenia, hibbertia,* &c. It is distinguished from the magnoliaceæ and anonaceæ by the quinary number of the parts of its flower.

They are generally astringent, but their properties are not much known. *Dillenia spearsa* is an elegant tree of India, with large yellow flowers, not inferior to the magnolia. *Hibbertia volubilis* has also beautiful flowers, which have a fœtid smell.

MAGNOLIACEÆ, Jussieu. This family is composed of large trees, or elegant shrubs, adorned with beautiful alternate leaves, often coriaceous and persistent, and furnished at their base with foliaceous stipules. The flowers, which are often very large, and diffuse a sweet scent, are generally axillar. The calyx is composed of from three to six caducous sepals. The petals vary from three to twenty-seven, and are disposed in several series. The stamina, which are very numerous and free, are disposed in several series, and attached to the receptacle which bears the petals. The pistils are numerous, sometimes collected in a circular form and in a single series in the centre of the flower, sometimes forming a more or less elongated capitulum. These pistils are composed of an unilocular ovary, containing one or more ovules, of a hardly distinct style, and a simple stigma. The fruits are composed of dry or fleshy carpels, aggregated circularly and in a stellate form, or disposed in capitula, and sometimes all united together. Each carpel is indehiscent, or opens by a longitudinal suture; and the seed is sometimes supported upon a sutural filiform trophosperm, which hangs at the exterior when the fruit opens. These seeds have their embryo erect in a fleshy endosperm.

The family is subdivided into—

ILLICIEÆ: carpels verticillate, rarely solitary, through abortion: leaves marked with transparent dots, as *illicium, drimys, tasmannia.*

MAGNOLIACEÆ: carpels disposed in capitula; leaves not dotted, as *magnolia, michelia, talauma, liriodendron,* &c.

This family is very nearly allied to the anonaceæ, from which it differs especially in its stipules and the continuous structure of its endosperm. It is also allied to the dilleniaceæ, which differ from it in the quinary number of the parts of the flower.

The bark of *magnolia, liriodendron,* and indeed of all the genus, is bitter and tonic. The flowers of the former are fragrant, but produce sickness and headache. All the species are exclusively natives of America or Asia.

ANONACEÆ, Jussieu. The anonaceæ are trees or shrubs having simple, alternate leaves, destitute of stipules, by which character they are distinguished from the magnoliaceæ. Their flowers are commonly axillar, sometimes terminal. The calyx is persistent, with three deep divisions. The corolla is formed of six petals, disposed in two series. The stamina are very numerous, forming several series; their filaments short, their anthers almost sessile. The carpels, which are generally aggregated in great number in the centre of the flower, are sometimes distinct, sometimes connected; each of them has a single cell, which contains one or more ovules attached to their inner suture, and often forming as many distinct fruits (rarely one only in consequence of abortion); sometimes they are united together, and form a kind of fleshy and scaly cone. The seeds have their integument formed of two lamineæ. Their horny endosperm is deeply grooved, and contains a very small embryo situated near the point of attachment of the seed.

This family, in which are placed the genera *anona, kadsura, asimina, uvaria,* &c., is very closely allied to the magnoliaceæ, from which it differs especially in the absence of stipules, in the petals, the number of which never exceeds six, and in having the endosperm deeply and irregularly grooved.

They are generally aromatic. The fruit of several species is saccharine and mucilaginous. That of the cherimonyer is esteemed next to the mangostan. The hard fruits of the *uvaria* are highly aromatic, that of one species furnishes the *piper æthiopicum* of the shops. They are all tropical plants.

BERBERIDEÆ, Jussieu. These consist of herbs or shrubs, with alternate, simple, or compound leaves, accompanied at their base by stipules, which are often persistent and spinous. Their flowers are generally yellow, and disposed in spikes or racemes. They have a calyx of from four to six sepals, rarely of a greater or of a less number, accompanied externally with several scales. The petals are of the same number as the sepals, flat or concave and irregular, but always opposite to the sepals. They are often furnished at their inner base with small glands or glandular scales. The stamina are equal in number to the petals and opposite to them. The anthers, which are sessile or supported by a filament of variable length, have two cells, each of which opens by a kind of valve, similar to those in the family of laurineæ. The ovary has a single cell, which contains from two to twelve ovules, which are erect or laterally attached to the inner wall, there forming one or two rows. The style, which is sometimes lateral, is short, thick, or wanting. The stigma is generally concave. The fruit is dry or fleshy, unilocular and indehiscent. The seeds are composed

of a proper integument, covering a fleshy or horny endosperm, which contains an axile and homotrope embryo.

This family, from which have been removed several of the genera placed in it by Jussieu, is composed of the following: *berberis, mahonia, wandinia, leontice, caulophyllum, epimedium,* and *diphylleia.*

The berries of *berberis vulgaris* are acid, and used as a preserve, but the other species are of little interest.

MENISPERMEÆ, Jussieu. This family is composed of sarmentaceous and climbing shrubs, of which the alternate leaves are generally simple, rarely compound. The flowers are small, unisexual, and most commonly diœcious. The calyx is composed of several sepals, arranged by threes, and forming several series. This is also the case with the corolla, which, however, is sometimes wanting. The stamina are monadelphous or free, of the same number as the petals, or of double or triple the number. The pistils, which are often very numerous, are free or united at their inner side, and are one-celled, containing one or more ovules. The fruits are small, compressed, oblique, somewhat reniform, monospermous drupes. The seed which they contain is composed of an embryo bent upon itself, and generally destitute of endosperm.

The genera are *menispermum, cocculus, cissampelos, abuta, lardizabala,* &c.

Columbo, *menispermum palmatum,* is astringent and tonic, and several species of *cocculus* are employed as tonics in Brazil. *Cocculus Indicus,* the seed of *menispermum cocculus,* is used in India for poisoning fishes. They are all natives of the tropical parts of America and Asia.

OCHNACEÆ, De Candolle. Woody plants, very smooth in all their parts, having alternate leaves, furnished with two stipules at their base, pedunculate flowers, very rarely solitary, or more commonly disposed in branched racemes. Their peduncles are articulated towards the middle of their length. They have a calyx with five deep divisions, which are laterally imbricated previous to their expansion; and a corolla of from five to ten spreading petals, imbricated during præfloration. The stamina vary from five to ten, and even more, having their filaments free, and inserted like the petals beneath a very prominent hypogynous disk, on which the ovary is inserted. The ovary is depressed at its centre, and appears formed of several distinct pistils ranged around a central style, which seems to arise immediately from the disk. The style is simple, and bears at its summit a variable number of stigmatiferous divisions. The fruit is composed of the cells of the ovary, which are separated from each other, and form so many drupaceous carpels, supported upon the disk or gynobasis, which has become enlarged. These carpels, of which several are sometimes abortive, are unilocular, monospermous, and indehiscent. Their seed contains a large erect embryo destitute of endosperm.

To this family are referred the genera *ochna, gomphia, walkera, meesia,* &c.

They are ornamental yellow flowered shrubs. The root and leaves of *walkera serrata* are tonic and stomachic.

RUTACEÆ, Adr. de Jussieu. *Zygophylleæ* and *diosmeæ,* Brown. *Simarubeæ,* Rich. A large family, composed of trees, shrubs, or herbaceous or frutescent plants, having opposite or alternate leaves, very frequently marked with transparent dots, with or without stipules. Flowers generally hermaphrodite, very rarely unisexual. Calyx of from three to five sepals, united at the base. Corolla of five petals, sometimes united together and forming a pseudo-monopetalous corolla, more rarely wanting. Stamina five or six, some of them occasionally abortive, and of various forms. The ovary is composed of from three to five carpels, more or less intimately united, and forming so many more or less prominent ribs. Each cell contains frequently two, more rarely one, or a considerable number of ovules, inserted at their inner angle, and there forming two rows. The styles are free or united. The fruit is sometimes simple, forming a capsule, opening into as many septiferous valves as there are cells; sometimes and more commonly it separates into as many cocca or carpels, which are usually monospermous and indehiscent, sometimes slightly fleshy, or dry and opening into two incomplete valves.

The numerous and rather heterogeneous species, have been divided into five tribes:—

1. ZYGOPHYLLEÆ: flowers hermaphrodite, cells of the ovary containing two or more ovules; as *tribulus, fagonia, guaiacum, zygophyllum,* &c.

2. RUTACEÆ: flowers hermaphrodite; two or more ovules in each cell; leaves alternate, as *ruta, peganum,* &c.

3. DIOSMEÆ: flowers hermaphrodite; two or more ovules; as *dictamnus, diosma, boronia, ticorea, galipea,* &c.

4. SIMARUBEÆ: flowers hermaphrodite or unisexual; cells with a single ovule; carpels distinct, indehiscent; as *simaruba, quassia, simaba,* &c.

5. XANTHOXYLEÆ: flowers unisexual; cells containing from two to four ovules; embryo placed at the centre of a fleshy endosperm, as *galvezia, aylanthus, brucea, xanthoxylum, toddalia, ptelea,* &c.

The plants of this family are generally characterized by being intensely bitter, as *rue; angustura, quassia,* and others are acrid, or aromatic. The guiacums are stimulating and tonic.

PITTOSPOREÆ, Brown. Shrubs sometimes sarmentaceous and twining, with simple and alter

nate leaves, destitute of stipules. Flowers solitary, fasciculate, or disposed in terminal clusters. Their calyx is monosepalous, with five deep divisions. The corolla is composed of five equal petals, united at the base, so as to form a regular monopetalous corolla, which is tubular, or spread out in a rosaceous manner. The five stamina are erect, hypogynous, as is the corolla. The ovary is free, supported upon a kind of hypogynous disk. It has one or two cells, separated by incomplete dissepiments, which frequently do not join at the centre of the ovary, rendering that organ unilocular. The ovules are numerous, attached in two longitudinal and distinct series towards the middle of the dissepiment. The style is sometimes very short, terminated by a small two-lobed stigma. The fruit is a capsule, with one or two polyspermous cells, opening by two valves, or a fleshy indehiscent fruit. The seeds are composed of a somewhat crustaceous proper integument, a white and fleshy endosperm, and an extremely small embryo, situated towards the hilum, and having its radicle turned towards it.

The genera which compose this family, were formerly placed among the rhamneæ; but their hypogynous insertion removes them to a wide distance. M. Decandolle places the pittosporeæ between the polygaleæ and the Frankeniaceæ. The following are the principal genera of this family: *pittosporum*, *billardiera*, *bursaria*, *senacia*. They are handsome, and rather ornamental shrubs, of tropical countries.

Geraniaceæ. Herbaceous or suffrutescent plants, with simple, or rarely compound, alternate leaves, with or without stipules at their base. The flowers are axillar or terminal. Their calyx is formed of five sepals, often unequal, and united together at their base, sometimes prolonged into a spur. The corolla is composed of five equal or unequal petals, free or slightly coherent, generally spirally twisted previous to their expansion. The stamina are from five to ten, rarely seven; they are free, or more frequently monadelphous by the base of their filaments. Their anthers are two-celled. The carpels are from three to five, more or less intimately united together. They have each a single cell, containing one, two, or a greater number of ovules, attached at its inner angle. The styles, which spring from the summit of each ovary, remain distinct, or are united together, and are each terminated by a simple stigma. The fruit is composed of from three to five cocca, containing one or two seeds, remaining indehiscent, or opening by their inner side; or it is a capsule, with five polyspermous cells, opening with five valves, sometimes elastically. The seeds, of which the proper integument is sometimes externally fleshy or crustaceous, is composed of a straight or more or less curved embryo, immediately covered by the proper integument, or placed in a fleshy endosperm.

The family is thus divided.

1. Oxalideæ; leaves usually compound, without stipules; flowers axillar, capsule with five polyspermous cells, styles distinct, embryo straight, in a fleshy endosperm, as *oxalis*.

2. Tropæoleæ; leaves simple, without stipules; flowers axillar, three indehiscent, monospermous cocca; embryo destitute of endosperm. *Tropæolum.*

3. Balsamineæ; leaves simple, without stipules; flowers irregular; no style; capsule with five polyspermous cells, opening elastically; embryo without endosperm. *Balsamina.*

4. Linaceæ; leaves simple, without stipules; flowers terminal, regular; three or five distinct styles; capsule with five two-seeded cells; endosperm thin. *Linum.*

5. Geraniaceæ; leaves simple, furnished with stipules; flowers opposite to the leaves; styles united; cocca indehiscent; embryo generally without endosperm. *Geranium erodium, pelargonium, monsonia.*

Some botanists constitute each of these divisions a distinct natural family.

The pelargoniums or geraniums, are highly esteemed as ornamental flowers.

The leaves and stems of the oxalideæ are usually acid. The tropoæoleæ are acrid, and possess the properties of the cruciferæ. *Linum catharticum* is purgative. The seeds of *linum usitatissimum* are mucilaginous, oleaginous, and emollient. The fibrous bark forms linen.

Malvaceæ, Kunth. *Part of the malvaceæ of* Jussieu. This family contains herbaceous plants, shrubs, and even trees, with alternate, simple, or lobed leaves, furnished with two stipules at their base. The flowers are axillar, solitary, or variously grouped, and forming a kind of spikes. The calyx is often accompanied externally with another, formed of leaflets, varying in number, and variously united. It is monosepalous, with three or five divisions, placed close together in the form of valves, previous to expansion. The corolla is generally composed of five petals, alternate with the lobes of the calyx, spirally twisted at first, often united together at their base, by means of the filaments of the stamina, so that the corolla falls off entire. The stamina are generally very numerous, rarely of the same number as the petals, or double their number. Their filaments are united, and form a tube, and their anthers are reniform and always unilocular. The pistil is composed of several carpels, which are sometimes verticillate around a central axis, and more or less united together, sometimes collected into a kind of capitulum. These carpels are unilocular, containing one, two, or a greater number of ovules attached at their inner angle. The styles are distinct, or more or less united,

and bear each a simple stigma at their summit. The fruit presents the same modifications as the carpels, that is, the latter are sometimes united, in a circular manner, around an axis, sometimes collected into a head, or form, by their union, a many-celled capsule, which opens into as many valves as there are monospermous or polyspermous cells. At other times, the carpels open only by their inner side. The seeds, of which the proper integument is sometimes covered with cottony hairs, are composed of a straight embryo, generally without endosperm, having the cotyledons foliaceous, and folded upon themselves.

Mr Brown considers the malvaceæ, not as a family, but as a great tribe or class, composed of the malvaceæ of Jussieu, the sterculiaceæ of Ventenat, the chlenaceæ of Du-Petit-Thouars, the tiliaceæ of Jussieu, and a new family which he names *byttneriaceæ*.

The following are among the genera of which it is composed: *malope, malva, althæa, lavatera, hibiscus, gossypium, palava, lagunea*, &c.

The malvaceæ abound in mucilage, and are consequently demulcent. The marsh mallow *(althæa officinalis)* has long been employed as such, but any of the other European species may be used with equal advantage. No plant belonging to this family is known to possess unwholesome qualities. The hairy covering of the seeds of several species of *gossypium*, is the cotton of commerce.

Bombaceæ, Kunth. Large trees or shrubs, natives of intertropical countries, having alternate, simple, or digitate leaves, furnished at their base with two persistent stipules. The calyx, which is sometimes accompanied externally with some bracteas, is monosepalous, with five divisions, which are imbricated previous to their expansion, sometimes entire. The corolla, which is sometimes wanting, is composed of five regular petals. The stamina, five, ten, fifteen, or more, are monadelphous at their base, and form five bundles above, each bearing one or more unilocular anthers. The ovary is formed of five carpels, which are sometimes distinct, sometimes united together, and terminated each by a style and a stigma, which are sometimes united into one. The fruits are generally five-celled, polyspermous capsules, opening by five valves, or they are coriaceous, internally fleshy, and indehiscent. The seeds, which are often surrounded by hairs or down, sometimes have a fleshy endosperm, covering an embryo, of which the cotyledons are even or puckered. The endosperm is sometimes wanting.

The genera are: *bombax, helicteres, matisia, cavanillesia, adansonia*, &c.

They are mucilaginous, like the malvaceæ. The baobab or adansonia, is the largest known tree, its diameter being from twenty to thirty feet at the base. The seeds of many species are enveloped in cottony hairs, which are used for various purposes, although they cannot be manufactured into thread.

Byttneriaceæ, Brown. (Some genera of *malvaceæ*, and the *hermanniæ* of Jussieu. *Sterculiaceæ*, Ventenat.) Trees or shrubs with simple, alternate leaves, furnished with opposite stipules. Flowers disposed in more or less branched clusters, which are axillar, or opposite to the leaves. The calyx, which is naked, or accompanied with a calyculus, is formed of five petals, more or less united at their base, and valvar. The corolla is of five flat petals, spirally twisted before expansion, or more or less concave and irregular. The petals are sometimes wanting. The stamina, which are of the same number as the petals, double or multiple, are in general monadelphous, and the tube which they form by their union often presents petaloid appendages, placed between the antheriferous stamina, and which are so many abortive stamina. The anthers are always two-celled. The carpels, from three to five in number, are more or less completely united. Each cell contains two or three ascending ovules, or a greater number, attached to the inner angle of each cell. The styles remain free, or are more or less united together. The fruit is generally a globular capsule, accompanied by the calyx, with three or five cells opening into so many valves, which often bear the dissepiment on the middle of their inner face. The seeds have an erect embryo in a fleshy endosperm.

This family, which is distinguished from the malvaceæ by its two-celled anthers, and by the circumstance that its seeds are generally furnished with a fleshy endosperm, has been divided into six sections, or natural tribes:

1. Sterculiaceæ: flowers often unisexual; calyx naked, no corolla; ovary pedicellate, formed of five distinct carpels; endosperm sometimes wanting, as: *sterculia, triphaca, heritiera.*

2. Byttneriaceæ: petals irregular, concave, often terminated at their summit by a kind of ligule; stamina monadelphous; ovary with five cells, generally containing two erect ovules: *theobroma, abroma, guazuma, buttneria, ayenia.*

3. Lasiopetaleæ: calyx petaloid; petals very small, in the form of scales, or wanting; ovary with three or five cells, containing each from two to eight ovules. *Seringia, thomasia, keraudrenia.*

4. Hermannieæ: flowers hermaphrodite, calyx tubular; corolla of five flat petals, spirally rolled before expansion; five monodelphous or free stamina, opposite to the petals; cells polyspermous. *Melochia, hermannia, mahernia.*

5. Dombeyaceæ: calyx monosepalous; corolla of five flat petals, stamina equal, numerous, and monadelphous; ovary with three or five cells, containing two or more ovules. *Ruizia, dombeya, pentapetes.*

6. Wallichieæ: calyx surrounded by an involucre of from three to five leaflets; petals flat; stamina very numerous, monadelphous, unequal, and forming a column similar to that of the malvaceæ, *eriolæna, wallichia, gœthea.*

Many of the sterculias are noble trees, with large edible seeds. Those of the famous kola, are said, when chewed, to render bad water sweet. The genus *astropæa,* are reckoned the most beautiful plants in the world: all the species are remarkable for the mucilage which they contain. Cocoa is prepared from the seeds of *theobroma cacao.*

Chlenaceæ, Du-Petit-Thouars. This little family is composed of small shrubs, all natives of the island of Madagascar. Their leaves are alternate, furnished with stipules, entire and caducous. The flowers form branched racemes. They are furnished with persistent involucres, which contain one or two flowers. Their calyx is small, formed of three sepals. The petals vary from five to six: they are sessile, and sometimes united at their base. The stamina, which are ten, or an indeterminate number, are united by their filaments, and sometimes adhere to each other by their anthers. The ovary has three cells, surmounted by a simple style, and a trifid stigma. The fruit is a capsule, with three cells, rarely with only one, through abortion, containing each one or more seeds, inserted at their inner angle, and pendant. These seeds contain an axile embryo, in a fleshy or horny endosperm.

Tiliaceæ, Jussieu. (*Tilliaceæ* and *elæocarpeæ,* Jussieu.) Almost all the tiliaceæ are trees or shrubs, a small number only being herbaceous plants. They bear alternate, simple leaves, accompanied at their base by two caducous stipules. Their flowers are axillar, pedunculate, solitary, or variously grouped. They have a simple calyx, formed of four or five sepals, placed close together in the form of valves, previous to the expansion of the flower; a corolla having the same number of petals, which are rarely wanting, and are often glandular at their base. The stamina are numerous, free, with bilocular anthers. A pedicellate gland is often seen on the face of each petal. The ovary has from two to ten cells, containing each several ovules attached, in two rows, to the inner angle. The style is simple, terminated by a lobed stigma. The fruit is a capsule, with several cells, containing several seeds, and sometimes indehiscent, or a monospermous drupe, through abortion. The seeds contain a straight or slightly curved embryo, in a fleshy endosperm.

The family is thus divided into two sections:

1. The true Tiliaceæ, comprehending the genera *tilia, sparmannia, heliocarpus, corchorus, triumfetta, apeiba,* &c.

2. The Elæocarpeæ, to which belong the genera *elæocarpus, vallea, decadia,* &c.

The tilliaceæ are allied to the malvaceæ, from which they differ in having the stamina free, and the embryo placed at the centre of a fleshy endosperm; and to the byttneriaceæ, from which they are distinguished by their stamina being free and numerous, their style simple, &c.

The tilliaceæ are mucilaginous, like the families to which they are allied. The properties of the elæocarpeæ are unknown.

Ternstrœmiaceæ; Camellieæ. (*Ternstrœmiaceæ* and *theaceæ,* Mirbel.) Trees or shrubs, with alternate leaves, destitute of stipules, often coriaceous and persistent. Flowers sometimes very large, axillar, and terminal, having a calyx formed of five concave, unequal, and imbricated sepals, and a corolla composed of five petals, sometimes united at their base, and forming a monopetalous corolla. The stamina are numerous, often connected by the base of their filaments, and united to the corolla. The ovary is free, sessile, generally applied upon a hypogynous disk, divided into from two to five cells, each containing two, or a greater number of pendant ovules, inserted at the inner angle. The number of styles is the same as that of the cells; each of them is terminated by a simple stigma. The fruit has from two to five cells. It is sometimes coriaceous, indehiscent, a little fleshy internally; at other times dry, capsular, and opening by as many valves. The seeds, which are often only two in each cell, have their embryo naked, or covered with a fleshy, often very thin endosperm.

This family now contains the genera *ternstrœmia, thea, camellia, fraziera,* &c.

The camellias are highly ornamental trees. The tea plant belongs to this family.

Olacineæ, Mirbel. This little family, which has been formed of part of the aurantiaceæ, is composed of woody plants, bearing simple, alternate, petiolate leaves, without stipules, and very small axillar flowers. The flowers are composed of a very small, monosepalous, persistent, entire, or toothed calyx, often attaining a large size, and becoming fleshy. The corolla is formed of from three to six petals, which are coriaceous, sessile, valvar, free, or united at the base. These petals, which sometimes bear the stamina, are often united two and two, and only separated at their summit. The stamina are generally ten in number, several of them being sometimes abortive, and existing under the form of sterile filaments. They are immediately hypogynous, or are borne upon the petals. The ovary is free, one-celled, generally containing three ovules, which are pendant at the summit of a central, erect trophosperm. The style is simple, terminated by a very small, three-lobed stigma. The fruit is drupaceous, indehiscent, often covered by the calyx, which has become fleshy, and one-seeded. The seed is composed of a

large fleshy endosperm, in which is contained a small basilar and homotrope embryo.

This little family, which is composed of the genera *olax, fisilia*, &c., is very distinct from the aurantiaceæ, in having its leaves without dots, its stamina definite, its ovary always unilocular, and its embryo contained in a very large endosperm.

According to Mr Brown, the genus *olax* is apetalous; in other words, its flower is a calyciform involucre, and a calyx formed of three sepals; and, on account of the internal structure of its ovary, it approaches the santalaceæ.

Marcgraviaceæ, Choisy. Shrubs very frequently sarmentaceous and climbing, parasitic in the manner of the ivy, having the leaves alternate, simple, entire, coriaceous and persistent; the flowers generally disposed in a short spike, resembling a cyme. The flowers are sometimes oblique at the summit of their long peduncle, which pretty generally bears an irregular bractea, hollow and cowl-shaped, or like a horn. They are hermaphrodite, with a calyx of from four to six or seven short, imbricated, and generally persistent sepals. The corolla is monopetalous, entire, rising like a kind of hood, or formed of five sessile petals. The stamina, which are usually numerous (five only in *souroubea*), have their filaments free. The ovary is globular, surmounted by a sessile stigma, lobed in a stellate form, which is rarely supported upon a style. It has a single cell, which has from four to twelve parietal trophosperms, projecting in the form of half dissepiments, divided at their free edge into two or three variously contorted laminæ and all covered with very small ovules. The fruit is globular, coriaceous, internally fleshy, indehiscent, or bursting irregularly into a certain number of valves, the dehiscence of which takes place towards the summit, and which bear a trophosperm on the middle of their inner face. The seeds are very small, and contain immediately under their proper integument a homotrope embryo.

The genera of which this family is composed are: *marcgravia*, *antholoma*, *noranthea*, and *souroubea*. This group is related to the guttiferæ; but it is also very intimately allied to the bixineæ and flacourtianeæ, which have also a polypetalous corolla, and indefinite stamina, a unilocular fruit, and parietal trophosperms. But, in these two families, the leaves are accompanied with stipules, and the embryo is covered by an endosperm.

Some of them bear large and showy flowers, among which are hollow, pitcher-like appendages.

Guttiferæ, Jussieu. This family is composed of trees or shrubs, sometimes parasitic, and all abounding in yellow and resinous proper juices. Their leaves, which are opposite, or more rarely alternate, are coriaceous and persistent. Their flowers, which are disposed in axillar racemes, or terminal panicles, are hermaphrodite, or unisexual and polygamous. Their calyx is persistent, formed of from two to six rounded, often coloured sepals. The corolla is composed of from four to ten petals. The stamina, which are very numerous, rarely in definite number, are free. The ovary is simple, and surmounted by a short style, which is sometimes wanting, and which bears a peltate, radiate, or lobed stigma. The fruit is sometimes capsular, sometimes fleshy or drupaceous, and sometimes opens by several valves, of which the generally inflicted margins are fixed to a single placentum, or to several thick placentas. The seeds are composed of a homotrope embryo destitute of endosperm. The guttiferæ comprehend a considerable number of genera, all extra-European, such as *clusia*, *godoya*, *mahurea*, *garcinia*, *calophyllum*, &c. They differ from the hypericineæ in having their stamina entirely free, in being furnished with a milky juice, in the absence of transparent dots, &c.

The yellow juice in which these plants abound, is acrid and purgative. Gamboge, which is a drastic purgative, and affords a yellow paint, is the concrete juice of a plant of this family. The fruit of garcinia mangostana, is highly esteemed.

Hypericineæ, Jussieu. Herbaceous plants, shrubs, or even trees, often resinous, and sprinkled with transparent glands. Leaves opposite, very rarely alternate, simple. Flowers axillar or terminal, variously disposed. The calyx has four or five very deep, somewhat unequal divisions. The corolla is composed of four or five petals, spirally twisted previous to their evolution. The stamina are very numerous, united into several fasciculi by the base of their filaments, sometimes monadelphous or free. The ovary is free, globular, surmounted by several styles, which are sometimes united into one. It has as many polyspermous cells as there are styles. The fruit is a capsule, or a berry with several polyspermous cells. In the former case it opens by as many valves as there are cells, the margins of the valves being continuous with the dissepiments. The seeds, which are very numerous and very small, contain a homotrope embryo, destitute of endosperm.

This family is composed of a small number of genera: *hypericum*, *androsæmum*, *ascyrum*, *vismia*, &c. Most of the species have, in the substance of their leaves, transparent miliary glands, which, on being held between the eye and the light, look like so many little holes. This character, together with the very numerous stamina, and the polyspermous cells of the fruit, perfectly distinguish the hypericineæ from the families that are allied to it.

Aurantiaceæ, Correa. Some of the genera of *aurantia* of Jussieu. Very smooth, sometimes spinous trees or shrubs, bearing alternate and articulated leaves, which are simple, or more frequently pinnate, and furnished with vesicular glands, filled with a transparent volatile oil. The flowers are fragrant, and generally terminal. The calyx is monosepalous, persistent, with three or five more or less deep divisions. The corolla is of from three to five sessile petals, which are free or slightly united. The stamina, sometimes of the same number as the petals, or double that number, or a multiple of it, are free, or variously united by their filaments, and are attached beneath to a hypogynous disk, on which the ovary is applied. The ovary is globular, with several cells containing a single suspended ovule, or several ovules attached to the inner angle of the cell. The style, which is sometimes very short and thick, is always simple, and terminated by a simple or lobed discoid stigma. The fruit is generally fleshy internally, separated into several cells by very thin membranous dissepiments, containing one or more seeds inserted at their inner angle, and generally pendant. Externally, the pericarp is thick and indehiscent, studded with vesicles filled with volatile oil. The seeds contain one, sometimes two embryos, without endosperm.

The genera of which this family is composed are especially distinguished by their articulate, often compound leaves, furnished with vesicular glands, which exist also in the substance of their petals and pericarp, by their simple style, and the absence of endosperm in the seeds, as *citrus, limonia, murraya*, &c.

The orange, the lemon, the citron, and the lime, are the fruits of different species of *citrus*.

Ampelideæ, Rich. (*Vites*, Jussieu). Shrubs or small trees, which are twining, sarmentaceous, and furnished with tendrils opposite to the leaves, which are alternate, petiolate, simple or digitate, with two stipules at their base. The flowers are disposed in racemes, which are opposite to the leaves. The calyx is very short, often entire and nearly flat. The corolla is of five petals, which are sometimes coherent at their upper part, and rise all together in the form of a hood. The stamina, five in number, are erect, free, and opposite to the petals. The ovary is applied upon a hypogynous annular disk, lobed at its circumference. It has always two cells, each containing two erect ovules. The style, which is thick and very short, is terminated by a stigma which is slightly two-lobed. The fruit is a globular berry, containing from one to four erect seeds, having their episperm thick, their endosperm horny, and containing near their base a very small erect embryo.

This little family is composed of the genera *vitis, cissus*, and *ampelopsis*. The grape vine, *vitis vinifera*, is the most important of this family.

Hippocraticeæ, (Jussieu, *hippocrateaceæ*, Kunth, De Candolle). Shrubs or small trees, generally glabrous and sarmentaceous, bearing opposite, simple, coriaceous, entire or toothed leaves, and small, axillar, fasciculate or corymbose flowers. The calyx is persistent, with five divisions. The corolla is composed of five equal petals. The stamina are generally three in number, rarely four or five, having their filaments united at the base, and forming a tubular androphorum. The ovary is trigonal, with three cells, each containing four ovules attached to their inner angle. The style is simple, terminated by one or three stigmas. The fruit is sometimes capsular, with three membranous angles, sometimes fleshy; each cell generally contains four seeds. The seed has an erect embryo, without endosperm.

This family, which is composed of the genera *hippocratea, anthodon, raddisia, salacia*, &c., is allied to the acerineæ and malpighiaceæ. Very little is known of their properties.

Acerineæ, De Candolle. This family is composed of the genus *acer* alone, and presents the following characters: flowers hermaphrodite, or unisexual. Calyx with five more or less deep divisions, or entire. Corolla of five petals. Stamina double the number of the petals, inserted upon a hypogynous disk, which occupies the whole bottom of the flower. Ovary didymous and compressed, with two cells, each containing two ovules, attached at its inner angle. Style simple, sometimes very short, terminated by two subulate stigmas. The fruit consists of two indehiscent samaras, which are each prolonged into a wing on one side. The seeds present a spirally twisted embryo beneath their proper integument.

This family contains several valuable timber trees. Sugar is obtained from the juice of several American species of the maple.

Malpighiaceæ, Jussieu. Trees or shrubs, with opposite, simple, or compound leaves, often furnished with napiform hairs, and frequently accompanied at their base with two stipules. Flowers yellow or white, forming racemes, corymbs, or sertules, which are axillar or terminal. The pedicels which support the flowers are often articulated and furnished with two small bracteas near their middle. The calyx is monosepalous, often persistent, with four or five deep divisions. The corolla, which is sometimes wanting, is composed of five petals with long claws. The stamina, six in number, seldom fewer, are free or slightly united at the base. The pistil is sometimes simple, sometimes formed of three carpels, more or less united. Each carpel or cell contains either a single ovule suspended at the upper part

of the inner angle, or two ovules attached to the angle. The styles, three in number, are sometimes united. The fruit, which is dry or fleshy, is composed of three distinct carpels, or forms a capsula or a nuculanium, with three, rarely with two or a single cell. The capsule is usually marked with very prominent membranous wings, or spinous points. The nuculanium sometimes contains three unilocular nucules, sometimes a nucleus, with three monospermous cells. Each seed is composed of a proper integument of no great thickness, immediately covering a somewhat curved embryo.

The genera are: *malpighia*, *brysonima*, *hyptage*, *gaudichaudia*, *banisteria*, &c., M. De Candolle.

The properties of the malpighiaceæ are little known. The hairs of some species are pungent. The fruit of several is eaten in the West Indies. The bark of the horse-chestnut is bitter and astringent.

Erythroxyleæ, Kunth. Trees or shrubs with alternate or opposite, generally glabrous leaves, furnished with axillar stipules. The flowers are small, pedicellate, having a persistent calyx, with five deep divisions, and a corolla of five petals, which are destitute of claws, and furnished internally with a small scale. The stamina, ten in number, are monadelphous. The ovary is unilocular, containing a single pendant ovule, or it has three cells, of which two are empty. From the ovary spring three styles, which are sometimes distinct, sometimes united nearly to their summit. The fruit is a monospermous drupe, containing an angular seed, of which the hard and horny endosperm contains an axile and homotrope embryo.

This little family is composed of the genus *erythroxylum*, under the name of *sethia*.

Meliaceæ, (De Candolle, *cedreleæ*, Brown). Trees or shrubs with alternate, simple or compound leaves destitute of stipules. Flowers sometimes solitary and axillar, sometimes variously grouped in spikes or racemes. Calyx monosepalous, with four or five more or less deep divisions. Corolla with four or five valvar petals. Stamina generally double the number of the petals, rarely of the same or a greater number. They are always monadelphous, and their filaments form a tube, which bears the anthers sometimes at its summit, sometimes at its inner surface. The ovary is supported upon a hypogynous annular disk. It has four or five cells, generally containing two collateral and super-imposed ovules. The style is simple, terminated by a stigma, which is more or less deeply divided into four or five lobes. The fruit is sometimes dry, capsular, opening by four or five septiferous valves; sometimes fleshy and drupaceous, and occasionally unilocular through abortion. The seeds are composed of an embryo, sometimes enveloped in a thin or fleshy endosperm, which is wanting in other genera.

This family is divided into two natural tribes:

1. True Meliaceæ: cells of the fruit containing one or two seeds without wings or endosperm; embryo reversed; cotyledons flat and leafy, or thick and fleshy, as: *geruma*, *humiria*, *turræa*, *quivisia*, *strigilia*, *sandoricum*, *melia*, *trichilia*, *guarea*, &c.

2. Cedreleæ: cells of the fruit polyspermous, seeds generally winged, furnished with a fleshy endosperm, embryo erect, cotyledons leafy, as: *cedrela swietenia*, &c.

The bark of *canella alba* is aromatic and tonic. The root of *melia azedarach* is anthelmintic. Mahogany is the wood of *swietenia mahogani*, the bark of which, and of *S. febrifuga*, is tonic. The pulpy pericarp of *melia azedarachta*, like that of the olive, yields oil. The fruits of some Indian species are eaten.

Sapindaceæ, Jussieu. This family is composed of large trees or shrubs, sometimes of herbaceous and twining plants, bearing alternate and generally imparipinnate leaves, sometimes furnished with tendrils. Their calyx is composed of four or five sepals, which are free, or slightly united at the base. The corolla, which is sometimes wanting, is generally formed of four or five petals, which are sometimes naked, sometimes glandular near their middle, where they occasionally bear a petaloid lamina. The stamina, which are double the number of the petals, are free, and applied upon a flat, lobed, hypogynous disk, which fills all the bottom of the flower. The ovary is three-celled, each cell generally containing two super-imposed ovules attached to its inner angle. The style is simple at the base, trifid at the summit, which is terminated by three stigmas. The fruit is a capsule, sometimes vesicular, with one, two, or three cells, each containing a single seed. The seeds are composed of a large embryo, having its radicle curved over the cotyledons, and destitute of endosperm.

This family has been divided into three tribes:

1. Pallineæ: petals appendiculate; disk formed of distinct glands, placed between the petals and stamina; ovary with three monospermous cells; twining herbs or shrubs, furnished with tendrils, as: *cardiospermum*, *urvillea*, *sergania*, *paullinia*.

2. Sapindaceæ: petals not appendiculate, but glandular or bearded, rarely naked; disk annular, or sometimes glands united together; ovary with two or three monospermous cells; trees or shrubs not twining, as: *sapindus*, *talisia*, *schmidelia*, *euphoria*, *thoninia*, *cupania*, &c.

3. Dodonæaceæ: petals furnished with a scale at their base; ovary with two or three cells, containing two ovules; pericarp vesicular or winged:

embryo having its cotyledons spirally twisted, as: *kolreuteria, dodonæa*, &c.

The fruits of several species are eaten; but the leaves of many are poisonous. The fruit of *sapindus saponaria* is soapy, as its name implies, and used for washing linen.

POLYGALEÆ, Jussieu. This family consists of herbaceous plants or shrubs, with alternate, simple, entire leaves, and solitary, axillar, or spiked flowers. The flowers are composed of a calyx of four or five sepals laterally imbricated previous to their expansion, and of which two, sometimes more internal, are petaloid and coloured. The corolla is formed of from two to five petals, sometimes distinct, sometimes united together by means of the filaments of the stamina, which form a tube split on one side. The stamina, which are generally eight in number, are monadelphous. Their androphorum is divided above into two phlanages, each bearing four unilocular anthers, generally opening at the tip. More rarely, the stamina are from two to four, and free. The ovary is sometimes accompanied, at its base, by a hypogynous and unilateral disk, or formed of two lateral and lamellar appendages. It has two, more rarely one or three cells, each containing one or two ovules. The style is long, usually curved, and bearing a hollow, two-lobed, or unilateral stigma. The fruit is a capsule or a drupe. In the former case, it has two one-seeded cells, and opens into two septiferous valves. In the latter case, it is unilocular, one-seeded, and indehiscent. The seeds are pendant, generally accompanied by a kind of caruncle or arillus of diversified form. Their embryo is sometimes placed in a fleshy endosperm, and sometimes destitute of endosperm.

The genera are, *polygala, salomonia, comsperma, badiera, soulamea, krameria*, &c.

The root of *polygala senega* is stimulant, diuretic, diaphoretic, and purgative. Extract of ratanhia, the root of *krameria*, is used to adulterate or improve port wine. The roots of the plants of this family are generally bitter and more or less astringent.

TREMANDREÆ, Brown. This little family, which is formed of the two genera *tremandra* and *tetratheca*, is composed of shrubs having the general appearance of heaths, all natives of New Holland, bearing alternate or verticillate leaves, without stipules, simple or toothed, and often furnished with glandular hairs. The flowers are axillar and solitary. The calyx is composed of four or five unequal sepals, placed close together in the form of valves, previous to the expansion of the flower, and caducous. The corolla is composed of four or five equal petals, alternate with the sepals, and longer than the stamina. The stamina, eight or ten in number, are placed in pairs opposite the petals. Their anthers, which have two or four cells open at their summit by a small hole or a kind of tube. The ovary is ovoidal, compressed, with two cells, each containing two or three pendant ovules. The style is terminated by one or two stigmas; and the fruit is a compressed bilocular capsule, opening by two valves, which are septiferous in the middle. The seeds, which are inserted at the upper part of the dissepiment, are terminated by a carunculate appendage. The embryo is erect in a fleshy endosperm.

There are only seven species natives of New Holland.

FUMARIACEÆ, De Candolle. The fumariaceæ are all herbaceous plants, destitute of milky juice, and furnished with alternate compound leaves, having a great number of narrow segments. The flowers are rather small, and generally disposed in terminal spikes. Their calyx is composed of two very small, opposite, flat, and caducous sepals. The corolla is irregular, tubular, formed of four unequal petals, sometimes slightly united together at their base. The upper petal, which is the largest, is terminated, at its lower part, by a short, curved spur. The stamina, six in number, are diadelphous, or form two androphora, each of which carries at its summit three anthers, the middle anther two-celled, the others one-celled. The ovary is unilocular, and contains four or a great number of ovules attached to two longitudinal trophosperms, corresponding to each suture. The style is short, surmounted by a depressed stigma. The fruit is sometimes a globular akenium, monospermous through abortion, sometimes a many-seeded, two valved, occasionally vesicular capsule. The seeds are globular, furnished with a caruncula, and containing, in a fleshy endosperm, a small, somewhat lateral, sometimes curved and transverse embryo.

This family, composed of the genus *fumaria* and the genera formed of its different species, as *corydalis, diclytra, cysticapnos*, is distinguished from the papaveraceæ by the absence of milky juice, the irregular corolla, and the six diadelphous stamina.

This family does not contain any noxious plants, but otherwise they are of little importance.

PAPAVERACEÆ. Herbaceous, or more rarely suffrutescent plants, with alternate leaves, which are simple or more or less deeply cut, generally abounding in a white or yellowish milky juice. The flowers are solitary, or disposed in cymes or branched racemes. The calyx is formed of two, very rarely three concave, very caducous sepals. The corolla, which is sometimes wanting, is composed of four, very rarely of six flat petals, which are plaited and puckered previous to their expansion. The stamina, which are very numerous, are free. The ovary is ovoidal or globular, or narrow and approaching to linear, one-celled,

containing very numerous ovules attached to trosphosperms, which project in the form of laminæ or false dissepiments. The style, which is very short or scarcely distinct, is terminated by as many stigmas as there are trophosperms. The fruit is an ovoidal capsule, crowned by the stigma, indehiscent, or opening by pores under the stigma; or it is elongated in the form of a pod, opening by two valves, or breaking across by articulations. The seeds, which are usually very small, are composed of a proper integument, sometimes bearing a kind of small fleshy caruncula, and of a fleshy endosperm, in which is placed a very small cylindrical embryo.

Jussieu united with the papaveracea the genus *fumaria*, which is now considered a distinct family. The genera of the papaveraceæ are *papaver*, *argemone*, *meconopsis*, *sanguinaria*, *pocconia*, *remeria*, *gloucium*, *chelidonium*, and *hypecoum*.

Many of the poppies are possessed of a narcotic property. Opium is the concrete milky juice of *papaver album*. The seeds of the poppies, however, yield an oil which is perfectly free of deleterious properties, and is used in food. Other species of this family are purgative, emetic, and diaphoretic, as *sanguinaria canadensis*.

Many of this species are mere weeds.

Cruciferæ, Jussieu. This is one of the largest, most natural, and important families of the vegetable kingdom, composed of herbaceous or sometimes suffrutescent plants, most of which grow in Europe. Their leaves are alternate, simple, or more or less deeply incised; their flowers disposed in spikes, or in simple or paniculate racemes. The calyx is formed of four caducous sepals, two of which are sometimes swelled out at the base. The corolla consists of four unguiculate petals placed opposite each other in pairs, so as to represent a cross (whence the name of the family). The stamina, six in number, are tetradynamous, that is, there are four larger placed close to each other in pairs, and two smaller, opposite to each other. At the base of the stamina there are seen upon the receptacle two or four glands, one between each pair of large stamina, and a larger one under each of the small stamina.

The ovary is more or less elongated, with two cells separated by a false dissepiment. Each cell contains one or more ovules attached to the outer edge of the membranous dissepiment, which is merely a prolongation of the two sutural trophosperms. The style is short or almost none, and seems a continuation of the dissepiment: it is terminated by a two-lobed stigma. The fruit is a siliqua or a silicula, of variable form, indehiscent, or opening by two valves. The seeds are attached on each side of the dissepiment. Their embryo is immediately covered by the proper integument, and is more or less bent upon itself.

The genera which compose this family are exceedingly numerous, and there are upwards of 900 species. Linnæus divided them into two orders, according as the fruit is a silicula or a siliqua. In the first of these orders we find among others the genera *lapidium*, *thlaspi*, *isatis*, *myagrum*, *cochlearia*, *iberis*, *lunaria*, &c.; in the other the genera *cheiranthus*, *sisymbrium*, *hesperis*, *brassica*, *eruca*, *sinapis*, &c.

The properties of the cruciferæ are more or less acrid and stimulant, and are considered as antiscorbutic. Mustard, the seed of *sinapis nigra*, is extremely acrid, and is applied externally as a rubefacient or blister. The horseradish, the cress, the root of *raphanus maritimus*, and many other species, are equally pungent; the seeds contain fixed oil, which is extracted from those of some species. When the acrid principle is corrected by an abundant mucilage, the plants become useful as food, as is the case with the water-cress, the sea-kale, the field-mustard. Cultivation diminishes the acrimony, so as to render some species almost destitute of it, as in the numerous varieties of the cabbage and turnip.

Some of the species are beautiful and fragrant garden flowers, as the stock gelly flower, candy tuft, &c.

Capparideæ. Herbaceous or woody plants, bearing alternate, simple or digitate leaves, accompanied at their base by two foliaceous stipules. Their flowers are terminal, spiked or racemed, or axillar and solitary. The calyx is composed of four caducous sepals, very rarely united together at their base. The corolla is formed of four or five equal or unequal petals. The stamina are sometimes definite, more frequently indefinite. The ovary is simple, often raised upon a more or less elongated support, which bears the name of podogynum, at the base of which are inserted the stamina and petals. It has a single cell containing several trophosperms projecting in the form of plates or false dissepiments, bearing a great number of ovules. The fruit is dry or fleshy. In the former case, it is a kind of more or less elongated pod, opening by two valves, as in most of the cruciferæ. In the latter case, it is a unilocular, many-seeded berry, of which the seeds are either parietal, or are scattered in the pulp of which the fruit is composed. These seeds are generally reniform, composed of a dry, crustaceous episperm, which immediately covers a somewhat curved embryo, destitute of endosperm.

The principal genera of this family are: *capparis*, *cratæva*, *morisonia*, *Boscia*, *cleome*, &c.

The family is nearly allied to the cruciferæ, but differs from them in having their leaves furnished with stipules, their numerous stamina, and the structure of their fruit.

Their properties are similar to those of the cruciferæ. The caper plant belongs to this family, and the *cleome rosea*, as well as the species of *cratæra* are pretty garden flowers.

RESEDACEÆ, De Candolle. Plants generally herbaceous, rarely suffrutescent, with alternate leaves, destitute of stipules, and often having two glands at their base. The flowers form simple and terminal spikes. The calyx has from four to six deep and persistent divisions. The corolla is composed of the same number of petals alternating with the sepals. The petals are generally composed of two parts, a lower entire part, and an upper, divided into a greater or less number of segments. The stamina are generally in indeterminate number (from fourteen to twenty-six); their filaments free and hypogynous, their anthers two-celled, each cell opening by a longitudinal groove. Between the stamina and the petals, is a kind of annular, glandular mass, more elevated on the upper side, and thus forming a hypogynous disk of a peculiar kind. The pistil, which is slightly stipitate at its base, appears formed by the intimate union of three carpels, and is terminated above by three horns, each bearing a stigma at its summit. The ovary has a single cell, open at the top, containing a great number of ovules, attached to three parietal trophosperms, which are remarkable for not corresponding to the stigmas, but alternate with them. The fruit, which is very rarely fleshy, is commonly a more or less elongated capsule, naturally open at the summit, which is terminated by three angles; it is one-celled, and the seeds are arranged upon three parietal trophosperms. The seeds, which are very frequently kidney-shaped, are composed of a rather thick integument, a very thin fleshy endosperm, and an embryo bent in the form of a horse's shoe.

This family contains only the two genera *reseda* and *ochradenus*.

The species are generally weeds; *reseda lut ola* affords a yellow dye, and *r. odorata* is the common mignonette, the peculiarities of whose inflorescence have already been described.

FLACOURTIANEÆ, Rich. *Bixineæ*, Kunth. This family consists of shrubs with alternate, simple, entire, often coriaceous, persistent leaves, destitute of stipules, and pedunculate, axillar, often unisexual and diœcious, at other times with hermaphrodite flowers. Their calyx is formed of from three to seven sepals, which are distinct, or slightly connected at the base. The corolla, which is sometimes wanting, is composed of five or seven petals alternating with the sepals. The stamina, which are determinate or indeterminate in number, and inserted at the circumference of a hypogynous annular disk, which is rarely wanting, have their filaments free, and their anthers two-celled. The ovary is sessile or stipitate, globular, one-celled in all the genera of the family excepting *flacourtia*, in which it has from six to nine cells. In the former case, it contains a considerable number of ovules attached to parietal trophosperms, the number of which is the same as that of the stigmas, or of the lobes of the stigma. The fruit is unilocular, except in *flacourtia*. It is indehiscent, or dehiscent, and each of the valves bears a trophosperm on the middle of its inner face. In general the proper tegument of the seed is fleshy, and the embryo, which is homotrope and straight, is placed in the centre of the fleshy endosperm.

The principal genera which compose the flacourtianeæ are *flacourtia*, *roumea*, *kiggellaria*, *erythrospermum*, &c. This family is related to the capparideæ, from which it differs chiefly in having the embryo destitute of a fleshy endosperm, and the seeds inserted on the middle and not on the edge of the valves. It has also some affinity to the cisteæ and tiliaceæ. Little is known of the properties of the species, all of which are tropical.

CISTEÆ, De Candolle. Annular or perennial herbaceous plants, or shrubs, bearing entire, often opposite leaves, sometimes furnished with stipules. The flowers are axillar or terminal, solitary or spiked, in racemes or in sertules. Their calyx has three or five very deep divisions, sometimes equal, sometimes unequal, with two more external. The corolla has five puckered, very caducous petals, spread out in a rosaceous form, and sessile. The stamina are very numerous and free; the ovary globular, rarely unilocular, more commonly with five or ten cells, containing several ovules inserted at the inner edge of the dissepiments. In the unilocular ovary, the ovules are attached to parietal trophosperms. The style and stigma are simple. The fruit is a globular capsule enveloped in the calyx, which is persistent, with one, three, five, or even ten cells, and opening by three, five, or ten valves, each bearing one of the dissepiments and one of the trophosperms on the middle of its inner surface. The seeds, which are pretty numerous in each cell, contain an embryo, which is more or less curved, or spirally twisted, in a fleshy endosperm.

This small family contains only the genera *cistus* and *helianthemum*.

The *cistus* or rock roses are ornamental plants. The resinous substance called labdanum, used as an article of perfumery, is collected from *cistus creticus*.

DROSERACEÆ, De Candolle. Composed of herbaceous, annual or perennial, rarely suffrutescent plants, having alternate leaves, often furnished with glandular and pedicellate hairs, and rolled in the form of a crosier previous to their development. The calyx is monosepalous, with five deep divisions, or with five distinct sepals.

The corolla is composed of five flat and regular petals. The stamina, five in number, sometimes ten, alternate with the petals, and are free. Sometimes there are appendages of various forms on the face of each petal. The stamina are generally perigynous, and not hypogynous. The ovary is one-celled, rarely two or three-celled. In the former case, it contains a great number of ovules attached to three or five simple or bifid parietal trophosperms. In the other, the dissepiments appear formed by the trophosperms projecting in the form of plates, which meet and unite in the centre of the ovary. The stigmas, generally of the same number as the trophosperms or the cells, are sessile and radiating. The fruit is a capsule, with one or more cells, opening by its upper half only, into three, four, or five valves, bearing one of the trophosperms on the middle of their inner surface. The seeds, which are often covered with a loose tissue, contain an erect, nearly cylindrical embryo, in the interior of a thin endosperm, which is sometimes wanting.

The family of droseraceæ differs from the violarieæ, to which it comes very near, by its perigynous insertion, the absence of stipules, and the constant regularity of the flower. The species are marsh plants, and natives of temperate climates.

The *droseræ* or sundews, which are somewhat acrid, are said to be poisonous to cattle.

Violarieæ, Decandolle. Consisting of herbs or shrubs, with alternate, very rarely opposite leaves, furnished with two persistent stipules. The flowers are axillar and pedunculate. The calyx is composed of five sepals, which are equal or unequal, free, or slightly connected at the base, which is sometimes prolonged beneath their point of attachment. The corolla is composed of five unequal petals, of which the lower is prolonged at its base into a more or less elongated spur; very rarely the corolla is formed of five regular petals. The stamina, five in number, are almost sessile, placed close together, and in contact by the sides, with two introrsal cells. The two which are situated towards the lower petal, pretty frequently present an appendage in the form of a recurved horn, which arises from their dorsal part, and is prolonged into the spur. The ovary is globular, unilocular, and contains numerous ovules attached to three parietal trophosperms. The style is simple, a little geniculate at the base, enlarged towards its upper part, which is terminated by a somewhat lateral stigma, presenting a small semicircular pit. The fruit is a unilateral capsule, opening by three valves, each bearing a trophosperm on the middle of its inner surface. The seeds contain an erect embryo in a fleshy endosperm.

The violarieæ, which are composed of the genera *viola*, *ionidium*, *hybanthus*, *noisettia*, *conhoria*, *alsodeia*, are distinguished from the cisteæ by their irregular corolla, their five stamina, their enlarged and concave stigma, &c. They are also allied to the *polygaleæ*, and *droseraceæ*.

Violets are favourite garden flowers. Part of the ipecacuan of commerce is derived from South American species of *viola*. The roots of several European species, as the *canina* and *odorata*, possess similar properties, although in a less degree.

Frankeniaceæ, Auguste de St Hillaire. The frankeniaceæ are herbaceous or frutescent. Their leaves are alternate or verticellate, entire or serrate, with close lateral nerves, and furnished at their base with two stipules, which are wanting only in the genus *frankenia*. The flowers are axillar, disposed in simple or compound racemes, or in panicles. They are hermaphrodite: their calyx is formed of five sepals, slightly united at the base; the corolla of five equal or unequal petals. In the genus *sauvagesia*, there is observed moreover, a verticil of club-shaped filaments, and an internal corolla, which also exists in the genus *luxemburgia*. The stamina are five, eight, or indefinite in number; they are free, with two-celled extrorsal anthers, opening by a longitudinal slit or a pore. The ovary is elongated, ovoidal, or trigonal, often placed upon a hypogynous disk. It has a single cell, containing three parietal trophosperms, each bearing a considerable number of ovules. The style is slender terminated by an extremely small stigma. The fruit is a capsule, covered by the calyx, or by the inner corolla, with a single cell, which opens by three valves, the edges of which are slightly inflected, and form three incomplete valves, bearing the seeds, which, at the centre of a fleshy endosperm, contain a small cylindrical, homotrope, axile embryo.

This little family is composed of the genera *frankenia*, *lavradia*, *sauvagesia*, and *luxemburgia*.

Sauvagesia erecta is mucilaginous and diuretic. The properties of this family, however, are little known; and they have not much external beauty.

Caryophylleæ, Jussieu. The Caryophylleæ are herbaceous, rarely suffrutescent at their base. Their stems are often knotty and articulated. Their leaves simple, opposite, or verticillate. Their flowers, which are generally hermaphrodite, are terminal or axillar. Their calyx is composed of four or five sepals, which are distinct or united together, and form a cylindrical or vesicular tube, merely toothed at its summit. The corolla, which is of five petals, commonly unguiculate at their base, is very rarely wanting. The number of stamina is generally equal to, or double, that of the petals. In the latter case, five are alternate with the petals, and five are opposite to them, and are united beneath with the claws. They are all inserted upon a hypogynous disk, which supports the ovary. The

latter has from one to five cells, or is unilocular. The ovules, which are numerous, are attached to a central trophosperm. When it is many-celled, they are attached to the inner angle of each cell. The styles vary from two to five, and terminate each in a subulate stigma. The fruit is a capsule, very rarely a berry, having from one to five polyspermous cells. The capsule opens, either at its summit, by means of small teeth which separate from each other, or by complete valves. The seeds are sometimes flat and membranous, sometimes rounded. The embryo is curved, or as if rolled round the farinaceous endosperm.

The genera of this family form two divisions:

1. The DIANTHEÆ, which have a tubular monosepalous calyx, and petals with elongated claws. *Dianthus*, *silene*, *lychnis*, *agrostemma*, *cucubalus*, &c.

2. The ALSINEÆ, of which the calyx is spreading, and the petals without claws. *Arenaria*, *alsine*, *spergula*, *cerastium*, *mollugo*, &c.

Many of the species are weeds; the *arenaria*, *silene*, and especially the carnations, are ornamental flowers.

PARONYCHIEÆ, Auguste de St Hillaire. Herbaceous or suffrutescent plants, bearing opposite leaves, often connate at their base, with or without stipules, and small, axillar, or terminal flowers, which are naked, or accompanied with scariose bracteas. Their calyx, which is monosepalous, often persistent, has five more or less deep divisions, and not unfrequently forms a tube at its lower part, which is often thickened by a glandular prominence. The petals, five in number, very small and squamiform, or even wanting, are inserted at the upper part of the tube of the calyx. The stamina, also five, but of which some are occasionally abortive, are alternate with the petals, and have their anthers introrse. The ovary is free, with a single cell containing a single ovule placed at the summit of a basal podosperm, sometimes very long, in which case the ovule is reversed; at other times, several ovules are attached to a very short central trophosperm. The stigma is sometimes sessile and simple, sometimes bifid, and supported upon a rather short style. The fruit is a capsule, which opens by valves or slits, or remains closed. The seeds are composed of a proper integument, a cylindrical embryo applied upon one of the sides, or rolled around a farinaceous endosperm. The radicle is always directed towards the hilum.

This family, which was established by St Hillaire, is composed of genera taken from the amaranthaceæ, portulaceæ, and caryophylleæ, from which they differ, especially in having the insertion perigynous, whereas it is hypogynous in the other two.

These plants are slightly astringent, but are not known to possess any remarkable properties. Some of the species are ornamental.

PORTULACEÆ, Jussieu. These are herbaceous, rarely frutescent plants, with opposite, sometimes alternate, thick, and fleshy leaves, destitute of stipules. The flowers are generally terminal. Their calyx is commonly formed of two sepals, more or less connected, and often tubulate at the base. The corolla is composed of five petals, which are free, or slightly connected, so as to form a monopetalous corolla. The stamina are of the same number as the petals, inserted at their base, and opposite to them: more rarely they are more numerous. The ovary is free, or almost semi-inferior, with a single cell containing a variable number of ovules, arising immediately from the bottom of the cell, or attached to a central trophosperm. The style is simple, terminated by three or five filiform stigmas. The fruit is a unilocular capsule, containing three or more seeds, and opening either by three valves, or by two superimposed valves. The frequently crustaceous proper integument of the seed, covers a cylindrical embryo, which is wrapped over a farinaceous endosperm.

The principal genera are *portulaca*, *talinum*, *montia*, &c. They are all insignificant weeds.

FICOIDEÆ, Jussieu. The ficoideæ are generally succulent plants, like the crassulaceæ, with alternate or opposite leaves, and axillar or terminal, often very large flowers. The calyx is monosepalous, often campanulate and persistent, its limb sometimes coloured, and four or five lobed. Corolla polypetalous, the petals sometimes indeterminate in number, sometimes united into a monopetalous corolla: more rarely the corolla is wanting. The stamina are generally pretty numerous, free and distinct. The ovary is sometimes entirely free, sometimes adherent at its base to the calyx: it has from three to five cells, each containing several ovules attached to a trophosperm, which springs from the inner angle of each cell. It is surmounted by from three to five styles, each terminated by a simple stigma. The fruit is sometimes a berry, sometimes a capsule surrounded by the calyx, with from three to five polyspermous cells. The seeds have an embryo rolled around a farinaceous endosperm.

The principal genera of the family of ficoideæ are: *reaumuria*, *mesembryanthemum*, *nitraria*, *tetragonia*.

They are chiefly Cape plants, growing in arid situations, and form beautiful stove exotics.

SAXIFRAGEÆ, Jussieu. The saxifrageæ are herbaceous plants, rarely shrubs or trees, of which the leaves are alternate or opposite, simple, and sometimes compound, with or without stipules. The flowers, which are sometimes solitary, sometimes variously grouped into spikes, racemes, &c., have a monosepalous calyx, tubu-

lar beneath, where it is united to the ovary, and terminated above by three or five divisions. The corolla, which is very rarely wanting, is formed of four or five petals, sometimes united at their base. The stamina are generally double the number of the petals, sometimes indeterminate. The ovary has two, more rarely four or five cells. It is sometimes entirely free, sometimes semi-inferior or almost inferior, terminated at its summit by as many styles as there are cells. The cells usually contain several ovules, very rarely only one. The ovules are attached to a trophosperm placed along the dissepiment. The fruit, which is rarely fleshy, is generally a capsule, terminated above by two more or less elongated horns, and usually opening by two septiferous valves. The seeds have beneath their proper integument a fleshy endosperm, which contains an axile, homotrope embryo, sometimes a little bent.

This family, with the *cunoniaceæ* of Brown, contains *saxifraga*, *heuchera*, *tiarella*, *cunonia*, *weinnmannia*, &c.

The saxifrageæ are neat and pretty ornamental flowers; they are more or less astringent, but are not in general known to possess any remarkable properties. The roots of *saxifraga granulata* have been employed as a diuretic. That of *heuchera americana*, and the bark of the weinnmanniæ, are powerfully astringent.

Hamamelideæ, Brown. Shrubs with alternate, simple leaves, often furnished with two caducous stipules. The flowers are axillar, having a calyx composed of four sepals, sometimes united into a tube at their lower part, and attached to the ovary, which is semi-inferior. The corolla is composed of four elongated, linear, valvar petals, a little twisted previous to the expansion of the flowers. The stamina are four, alternate with the petals, having their anthers introrse, and two-celled, opening by a valvule, which is sometimes common to the two cells, and which occupies their inner face. Before each petal there is often a scale of diversified form, which appears to be an abortive stamen. The ovary is semi-inferior, or entirely free, with two cells, each containing a suspended ovule. From the summit of the ovary spring two styles, each terminated by a simple stigma. The fruit, which is enveloped by the calyx, is dry, with two monospermous cells, generally opening with two septiferous valves. The seeds are composed of a homotrope embryo, covered by a fleshy endosperm.

They are hardy American shrubs, with no marked properties.

Bruniaceæ, Brown. The plants which form this family are shrubs, which in habit greatly resemble the heaths and the phylicæ or Cape heaths. They are all natives of the Cape of Good Hope. Their leaves are very small, stiff, entire, sometimes imbricated. The flowers are small, disposed in capitula, more rarely in panicles. The calyx is monosepalous, with five divisions, generally adherent at its base to the ovary, which is inferior or semi-inferior (free in the genus *raspalia* alone): the five divisions are imbricated, as is the corolla, previous to expansion. The petals are five, and alternate. The five stamina alternate with the petals, and their filaments adhere laterally to the base of each of the petals, which has led some authors to consider them as opposite to the petals. The ovary is semi-inferior, or inferior, or free, with one or three cells, containing each one or two collateral suspended ovules. The style is simple or bifid, or the two styles are distinct and terminated each by a very small stigma. The fruit is dry, crowned by the calyx, corolla, and stamina, which are persistent. It is indehiscent, or separates into two generally monospermous cocca, opening by a longitudinal and internal slit. The seeds are suspended, and contain a very small homotrope embryo, placed near the base of a fleshy endosperm.

The genera are *berzelia*, *brunia*, *raspalia*, *staavia*, *berardia*, *linconia*, *audoninia*, *tittmannia*, and *tamnea*. The plants are ornamental but possess no known properties of importance.

Crassulaceæ, De Candolle. *Sempervivcæ*, Jussieu. This family is composed of herbaceous plants or shrubs, the leaves, stem, and in general all the herbaceous parts of which are thick and fleshy. The leaves are alternate or opposite. The flowers, which are sometimes very finely coloured, present various modes of inflorescence. Their calyx is deeply divided into a great number of segments. The corolla is composed of a variable, sometimes very great number of regular petals, which are distinct, or united into a monopetalous corolla. The number of stamina is the same as that of the petals, or of the lobes of the monopetalous corolla, or more rarely double their number. At the bottom of the flower are always several distinct pistils, varying from three to twelve, or even more. Each is composed of a more or less elongated ovary, having a single cell, containing several ovules attached to a sutural and internal trophosperm. The style and stigma are simple. The fruits are unilocular, polyspermous capsules, opening by their longitudinal and internal suture. Their seeds have a more or less curved embryo, in some degree enveloping a mealy endosperm.

This family, which is composed of succulent plants, is related to the ranunculaceæ, by its polyspermous unilocular capsules opening by a single longitudinal suture. But it approaches more to the saxifrageæ and ficoideæ, from which it differs especially in having distinct pistils at the centre of the flower. The principal genera

are: *tillæa, buliardia, crassula, cotyledon, bryophyllum, sedum,* and *sempervivum.*

The flowers are beautiful and ornamental; but otherwise these plants are not distinguished by any remarkable properties. They are insipid, or slightly acid, sometimes acrid.

Nopaleæ, Ventenat. Cactus, Jussieu. This family is composed exclusively of the genus *cactus* of Linnæus, and the divisions which have been made in it. They are perennial, often arborescent plants, of a very peculiar aspect, different from that of any other plants, excepting some *euphorbiæ.* Their stems are either cylindrical, branched, channelled, angular, or composed of articulated pieces, which have been considered as leaves. The leaves are almost always wanting, and are substituted by spines collected into fasciculi. The flowers, which are sometimes very large, and brilliantly coloured, are generally solitary, and placed in the axilla of one of the bundles of spines. The calyx is monosepalous, adherent to the inferior ovary, sometimes scaly externally, terminated at its summit by a limb composed of a great number of unequal lobes, which are confounded with the petals. The petals are generally very numerous, and disposed in several series. The stamina, which are also very numerous, have their filaments slender and capillar. The ovary is inferior, with a single cell, containing a great number of ovules, attached to parietal trophosperms, the number of which is very variable, and commonly in relation to that of the stigmas. The style is simple, terminated by three or a greater number of rayed stigmas. The fruit is fleshy, umbilicate at its summit. Its seeds have a double integument, and contain a straight or curved embryo, destitute of endosperm.

They are natives of dry tropical climates. The fruits are generally mucilaginous and insipid, though some of them are eaten.

Ribesiæ, Rich. *Grossulariæ,* Decandolle. Bushy, sometimes spinous shrubs, having alternate leaves, without stipules. The flowers are axillar, solitary, geminate, or disposed in spikes or simple racemes. The calyx is monosepalous, tubular inferiorly where it adheres to the ovary, having its limb bell-shaped, with five spreading or reflected divisions. The corolla is formed of five petals, which are sometimes very small. The stamina, which are of the same number as the petals, and alternate with them, are inserted about the middle of the limb of the calyx. The ovary is inferior, with a single cell, containing a great number of ovules, attached in several series to two parietal trophosperms. The two styles are more or less united together, and terminate each in a simple stigma. The fruit is a globular, umbilicate, polyspermous berry, and its seeds are composed of a thick embryo, immediately covered by the proper integument.

This family is allied to the nopaleæ, from which it differs, especially in the very different habit of the plants of which it is composed, in the circumstance of the petals and stamina being always five, and not in indeterminate number, as in the cacti, in their two trophosperms and their two styles. Richard proposed dividing the numerous species of this genus into three sections or sub-genera, of which the types are *ribes, uva-crispa, ribes, nigrum* and *ribes rubrum.* He names the first *grossularia,* the second *ribes,* the third *botryocarpum.*

The numerous varieties of gooseberries and currants belong to this family, of which the fruits are generally eatable, although some are insipid, and others extremely acid.

Cucurbitaceæ, Jussieu. Large herbaceous plants, often twining, covered with short and very stiff hairs. Their leaves are alternate, petiolate, more or less lobed. Their tendrils, which are simple or branched, arise beside the petioles. The flowers are generally unisexual and monœcious, very rarely hermaphrodite. The calyx is monosepalous: in the female flowers it presents a globular tube adherent to the inferior ovary. Its limb, which is more or less campanulate and five-lobed, is confounded and intimately united with the corolla, having only the tips of its lobes distinct. The corolla is formed of five petals, united together by means of the limb of the calyx, and thus representing a monopetalous corolla. The stamina, five in number, have their filaments monadelphous or united into three fasciculi, two formed each of two stamina, and the third of a single stamen. The anthers are unilocular, linear, bent upon themselves, in the form of the letter S placed horizontally, and with its branches very close. In the female flowers, the summit of the ovary, which is inferior, is crowned by an epigynous disk. The style is thick, short, terminated by three thick and often two-lobed stigmas. The ovary is one-celled in two genera, (*sicyos* and *gronovia*). It contains a single pendent ovule; but, in general, it presents three triangular, very thick parietal trophosperms, in contact with each other at their sides, and thus filling the whole cavity of the ovary, and giving attachment to the ovules at their point of origin upon the walls of the ovary. The fruit is fleshy, umbilicate at its summit: it is a peponida. The seeds, when the fruit is ripe, seem scattered in the midst of a filamentous or fleshy cellular tissue. The proper integument is rather thick, and immediately covers a thick homotrope embryo, destitute of endosperm.

The principal genera of this family are: *cucumis, cucurbita, pepo, ecballium, momordica. bryonia, gronovia,* &c., containing the melon, cucumber, pumpkin, and various gourds, which are articles of food. Colocynth, a strong purgative, is prepared from the pulp of *cucumis*

colocynthis. The roots of *bryonia alba* and *momordica elaterium* are also of a purgative quality.

LOASEÆ, Jussieu. Herbaceous, branched plants, often covered with hispid hairs, the stinging of which burns like that of a nettle. Their leaves are alternate or opposite, entire or variously lobed. Their flowers, which are pretty frequently yellow and large, are sometimes solitary, sometimes variously grouped. The calyx is monosepalous, tubular, free or adherent to the inferior ovary, having its limb with five divisions. The corolla is of five regular, flat or concave petals. The throat of the calyx is sometimes furnished with five appendages, or a divided border. The stamina, which are generally very numerous, are sometimes of the same number as the petals. The ovary is free or inferior, with a single cell, presenting internally three parietal trophosperms, sometimes projecting in the form of dissepiments, and bearing several ovules. The ovary is surmounted by three long, slender styles, sometimes united into one, and terminated each by a simple or penicillate stigma. The fruit is a capsule, crowned by the lobes of the calyx, or naked, opening at its summit only into three valves, which bear one of the trophosperms on the middle of their inner face, excepting in the genus *loasea,* in which the trophosperms correspond to the sutures. The seeds, which are sometimes arillate, present a homotrope embryo in a fleshy endosperm.

This family is composed of the genera *loasa, mentzelia, klaprothia, turnera* and *piriqueta.*

PASSIFLOREÆ, Jussieu. Herbaceous plants, or shrubs with sarmentaceous stems, furnished with extra-axillar tendrils, and alternate, simple or lobed leaves, accompanied with two stipules at their base. More rarely they are trees destitute of tendrils. Their flowers are generally large and solitary; more rarely they form a kind of raceme. They are hermaphrodite, with a monosepalous, turbinate, or long and tubular calyx, with five more or less deep, sometimes coloured divisions, and a corolla of five petals, inserted at the upper part of the tube of the calyx. The stamina are five, monadelphous at their base, and forming a tube which covers the support of the ovary, and is united with it. The anthers are versatile, and two-celled. Externally of the stamina, are appendages of very diversified form, sometimes filamentous, sometimes in the form of scales or of pedicellate glands, united circularly, and forming from one to three crowns, which arise at the orifice and upon the walls of the tube of the calyx. Sometimes these appendages, and even the corolla, are entirely wanting. The ovary is free, with a long stalk and a single cell, presenting from three to five longitudinal trophosperms, which sometimes project in the form of false dissepiments, and give attachment to a great number of ovules. It is surmounted by three or four styles, terminated by as many simple stigmas. In some rare cases the stigmas are sessile. The fruit is fleshy internally, containing a very great number of seeds; more rarely it is dry, but always indehiscent. The seeds have a fleshy endosperm, in which is a homotrope and axile embryo.

This family is composed of the genera *passiflora, tacsonia, murucuja, malesherbia, deidamia, kolbia,* and probably *carica,* which is also placed among the cucurbitaceæ.

The sweetish, fragrant, and cooling pulp of the fruits of several species is eaten. The fruit of the papaw, *carica papaya,* is eaten when ripe, and in the immature state is vermifuge.

The passion flowers are handsome twining greenhouse plants.

HYGROBIEÆ, Rich. *Cercodianeæ,* Jussieu. *Halorageæ,* Brown. A small family, composed generally of aquatic plants, often bearing verticillate leaves. The flowers are very small, axillar, sometimes unisexual, with a monosepalous calyx adhering to the inferior ovary, and terminated above by a limb with three or four lobes. The corolla, which is sometimes wanting, is composed of three or four petals alternate with the lobes of the calyx. The stamina are of the same or double the number of the petals, to which they are opposite in the former case. The ovary has from three to four cells, each containing a single reversed ovule. From the summit of the ovary spring three or four filiform, glandular, or downy stigmas. The fruit is a berry or a capsule, crowned by the lobes of the calyx, with several monospermous cells. The seeds are reversed, and contain a cylindrical, homotrope embryo in a fleshy endosperm.

The genera are *myriophyllum, haloragis, cercodia, proserpinaca, trixis,* and are all uninteresting weeds.

ONAGRARIÆ, Jussieu. Herbaceous, rarely frutescent plants, with simple, opposite, or scattered leaves, and terminal or axillar flowers. The calyx is adherent to the inferior ovary; its limb, four or five lobed. The corolla is formed of four or five petals, laterally incumbent and spirally twisted previous to expansion. It is rarely wanting. The stamina are of the same number as the petals, or double their number, sometimes fewer. The ovary is inferior, and has four or five cells, containing a considerable number of ovules, attached to their inner angle. The style is simple, and the stigma is sometimes simple, sometimes four or five-lobed. The fruit is a berry or a capsule, with four or five cells, each often containing only a small number of seeds, and opening by as many valves, bearing the dissepiments on the middle of their inner surface. The seeds have a proper integument,

generally formed of two laminæ, and immediately covering a homotrope embryo destitute of endosperm.

Jussieu's family of onagræ contained several genera which have been successively removed from it. Thus the genus *mocanera* appears to us to belong to the family of ternstrœmiaceæ; *cercodia* forms the type of the family of hygrobieæ; the genera *cacoucia*, and *combretum*, belong to the combretaceæ; *santalum* forms the type of the santalaceæ; the genera *mourira* and *petaloma* appear to us to belong to the melastomaceæ; and, lastly, the genera *loasa* and *mentzelia* constitute the family of loaseæ.

This family is composed, among others, of the genera *epilobium*, *œnothera*, *lopezia*, *circœa*, *jussiœa*, *fuchsia*.

Epilobium, *œnothera*, and *fuchsia*, are beautiful ornamental genera.

The roots of *œnothera biennis* are eaten, but the properties of this family are little known.

Combretaceæ, Brown. Genera *œlæagni* and *terminaliæ* of Jussieu. Trees or shrubs, with opposite or alternate leaves, which are entire and without stipules. Flowers hermaphrodite or polygamous, variously disposed in axillar or terminal spikes. The calyx is adherent by its base to the ovary, which is inferior; its limb, which is often tubular, has four or five divisions, and is articulated to the summit of the ovary. The corolla is wanting in several genera, or is composed of four or five petals inserted between the lobes of the calyx. The number of stamina is generally double that of the divisions of the calyx, but the number is not strictly determined. The ovary has a single cell, containing from two to four ovules hanging from its summit. The style varies in length, and is terminated by a simple stigma. The fruit is always unilocular, monospermous through abortion, and indehiscent. The seed, which is pendent, is composed of an endosperm, which immediately covers the embryo.

Among the genera are the *bucida*, *terminalia*, *conocarpus*, *quisqualis*, *combretum*, &c.

In their properties they are generally astringent and tonic. The bark of several species is used for tanning.

Myrtaceæ, Jussieu. This interesting family is composed of trees or shrubs of an elegant habit, and abounding in a resinous and fragrant juice. The leaves are opposite, entire, often persistent, and marked with translucid dots. The flowers are variously disposed, either in the axillæ of the leaves, or at the summits of the twigs. Their calyx is monosepalous, adherent by its base with the inferior ovary, having its limb with five, six, or only four divisions. The corolla, which is rarely wanting, is formed of as many petals as the calyx has lobes. The stamina, which are generally very numerous, rarely in determinate number, have their filaments free, or variously united, their anthers terminal and generally rather small. The ovary, which is inferior, has from two to six cells, which contain a variable number of ovules attached at their inner angle. The style is generally simple and the stigma is lobed. The fruit presents numerous modifications. It is sometimes dry, opening into as many valves as there are cells, sometimes indehiscent or fleshy. The seeds, which are generally destitute of endosperm, have an embryo the cotyledons of which are never either convolute, or rolled in a spiral form one upon the other.

De Candolle has divided the myrtaceæ into five natural tribes.

1. The Chamælaucieæ: fruit dry, unilocular; seeds basilar, calyx five-lobed, corolla of five petals, sometimes wanting; stamina free or polyadelphous. The genera which form this tribe are all natives of New Holland: *calytrix*, *chamælaucium*, *pileanthus*, &c.

2. Leptospermeæ: fruit dry, dehiscent, with several cells; seeds attached to the inner angle, destitute of arillus, and endosperm; leaves opposite or alternate. Shrubs all natives of New Holland: *beaufortia*, *calotamnus*, *tristania*, *melaleuca*, *eudesmia*, *eucalyptus*, *metrosyderos*, *leptospermum*, &c.

3. Myrteæ: fruit fleshy, generally with several cells; seeds without arillus or endosperm; stamina free; leaves opposite. Shrubs almost all natives of the tropics: *eugenia*, *jambosa*, *calyptranthes*, *caryophyllus*, *myrtus*, *campomanesia*, &c.

4. Barringtonieæ: fruit dry or fleshy; always indehiscent, with several cells; stamina monadelphous at their base; leaves alternate, not dotted. Trees of the equinoctial regions of the Old and New Continents: *dicalyx*, *stravadium*, *barringtonia*, *gustavia*.

5. Lecythideæ: fruit dry, opening by an operculum (pyxidium); stamina very numerous, monadelphous; leaves alternate, not dotted. Large trees of equinoctial America: *lecythis*, *couratari*, *couroupita*, *bertholletia*.

The myrtaceæ form a very distinct family among the dicotyledones with inferior ovary. It is allied to the melastomaceæ, which differ from it in the very remarkable and constant disposition of the nerves of their leaves, and in the number and structure of their stamina; to the onagrariæ, which differ in having their stamens determinate; to the rosaceæ, which are distinguished by their alternate leaves and multiple styles; and to the combretaceæ, in which the lobes of the embryo are convolute.

These plants generally contain a pungent or fragrant volatile oil, together with tannin and gallic acid. Cloves are the flowers of *caryophyllus aromaticus*. Pimento is obtained from a

species of myrtus. Cajeput oil is procured from the leaves of *melaleuca leucadendron*. The root of *eugenia racemosa* is employed in India as an aperient. The bark of the root of the pomegranate is astringent, and has been employed in diarrhœa, as well as a remedy for tape-worm. *Eucalyptus resinifera* yields a kind of gum; and the bark of several species is used for tanning. The fruits of the eugeniæ are eaten, as are those of several other species of this family. The myrtle is an ornamental evergreen.

Melastomaceæ, Jussieu. The melastomaceæ are large trees, trees of small size, shrubs or herbaceous plants, with opposite, simple leaves, generally furnished with from three to five or even eleven longitudinal nerves, from which proceed numerous other transverse, parallel, very close nerves. The flowers, which are sometimes very large, have in a manner every mode of inflorescence. The calyx is monosepalous, more or less adherent to the ovary, which is inferior, or semi-inferior: its limb is sometimes entire or toothed, or, lastly, has four or five more or less deep divisions. More rarely it forms a kind of hood or operculum. The corolla is composed of four or five petals. The stamina are double the number of the petals: their anthers present the most diversified and the most singular forms, and open at their summit by a hole or pore common to the two cells. The ovary is sometimes free, more commonly adherent to the calyx. It has from three to eight cells, each containing very numerous ovules. The summit of the ovary is often covered by an epigynous disk. The style and stigma are simple. The fruit is sometimes dry, sometimes fleshy, and has the same number of cells as the ovary. It remains indehiscent, or opens into so many septiferous valves. The seeds are frequently reniform: they contain an erect or slightly curved embryo, destitute of endosperm.

The species of this family are very numerous, and have been grouped into several genera, such as *melastoma*, *rhexia*, *miconia*, *tristemma*, *topobæa*, &c. It is so distinct in the disposition of the nerves of its leaves, that it cannot be confounded with any of the families which approach nearest to it, as the onagrariæ, myrtaceæ, and rosaceæ.

They are all handsome tropical shrubs, or trees, with large flowers, either purple or white. The fruit of true melastoma is a juicy insipid berry, eatable, but staining the teeth and mouth of a deep black.

Salicariæ, Jussieu. Herbs or shrubs with opposite or alternate leaves, bearing axillar or terminal flowers; a monosepalous, tubular, or urceolate calyx, toothed at its summit; a corolla of from four to six petals, which alternate with the divisions of the calyx, and are inserted at the upper part of its tube. The corolla is wanting in some genera. The stamina are equal to the petals in number, or double, or more rarely in indefinite number. The ovary is free, simple, with several cells, each containing a considerable number of ovules. The style is simple, terminated by a usually capitate stigma. The fruit is a capsule covered by the calyx, which is persistent, and has one or more cells, containing seeds attached at their inner angle. The seeds are composed of an embryo destitute of endosperm.

Among the genera which compose this family, are *lythrum*, *cuphea*, *ginoria*, *lagerstrœmia*, *ammania*. It is allied to the onagrariæ, from which it differs in having its ovary free, and to the rosaceæ, which have always stipules, and possess many other characters which distinguish them from the salicariæ.

Lythrum salicaria is astringent, and has been used in diarrhœa. The henne of the East is obtained from *lawsonia inermis*.

Tamariscineæ, Desvaux. Shrubs or small trees, generally with very small, squamiform and sheathing leaves, and small flowers, furnished with bracteas, and disposed in simple spikes, which are sometimes collected into a panicle. The calyx has four or five deep divisions, which are laterally imbricated: sometimes it forms a tube at its lower part. The corolla is composed of four or five persistent petals. The stamina, from five to ten, rarely four, are monadelphous at their base. The ovary is triangular, sometimes surrounded at its base by a perigynous disk. The style is simple or tripartite. The fruit is a triangular capsule, with a single cell, containing a pretty large number of seeds attached about the middle of the inner surface of the three valves which form the capsule. The embryo is erect, destitute of endosperm.

The ashes of *tamarix gallica* and *africana* contain a large quantity of sulphate of soda. The bark is generally bitter and astringent.

Rosaceæ, Jussieu. A large family composed of herbaceous plants, shrubs, and trees attaining very large dimensions. Their leaves are alternate, simple or compound, accompanied at their base by two persistent stipules, sometimes united to the petiole. The flowers present various modes of inflorescence. They have a monosepalous calyx, with four or five divisions, sometimes accompanied externally with a kind of involucre which is incorporated with the calyx, so that the latter appears to have eight or ten lobes. The corolla, which is rarely wanting, is composed of four or five regularly spreading petals. The stamina are generally very numerous and distinct. The pistil presents various modifications. Sometimes it is formed of one or several carpels, entirely free and distinct, and placed in a tubular calyx. Sometimes these carpels adhere by their outer side to the calyx; sometimes they are not only united to the calyx,

but to each other; sometimes they are collected into a kind of capitulum, upon a receptacle or gynophorum. Each of these carpels is unilocular, and contains one, two, or a greater number of ovules, the position of which varies greatly. The style is always more or less lateral, and the stigma simple. The fruit is extremely diversified: sometimes it is a true drupe, sometimes a melonida or an apple; sometimes one or more akenia, or one or more dehiscent capsules; or, lastly, an aggregation of small akenia or drupes, forming a capitulum upon a gynophorum which becomes fleshy. The seeds have their embryo monotrope and destitute of endosperm.

This extensive family has been divided into tribes, some of which have been considered as distinct families.

1. Chrysobalaneæ, Brown: ovary single, free, containing two erect ovules; style filiform, arising nearly from the base of the ovary; flowers more or less irregular; fruit drupaceous, as *chrysobalanus*, *parinarium*, *moquilea*, &c.

2. Drupaceæ, De Candolle: ovary single, free, containing two collateral ovules; style filiform, terminal; flowers regular; fruit drupaceous, as *prunus*, *amygdalus*, *cerasus*, &c.

3. Spiræaceæ, Rich: several ovaries, which are free or slightly attached to each other by their inner side, containing two or four collateral ovules; style terminal; capsules distinct, unilocular; or a single polyspermous capsule, as, *spiræa*, *kerria*.

4. Fragariaceæ, Rich: calyx spreading, often furnished with an external calyculus; several monospermous, indehiscent carpels, sometimes collected upon a fleshy gynophorum; style more or less lateral, as, *potentilla*, *fragaria*, *geum*, *rubus*, *dryas*, *comarum*, &c.

5. Sanguisorbeæ, Jussieu: flowers usually polygamous and sometimes destitute of corolla; one or two carpels, sometimes adherent to the calyx, terminated by a style and a styliform or penicillate stigma, as, *poterium*, *cliffortia*, *alchemilla*, &c.

6. Roseæ, Jussieu: calyx tubular, urceolate, containing a variable number of monospermous carpels attached to the inner wall of the calyx, which becomes fleshy and covers them, as, *rosa*.

7. Pomaceæ, Rich: several unilocular carpels, each containing two ascending ovules, rarely a great number attached to the inner side, united together and with the calyx, and forming a fleshy fruit, known by the name of melonida or apple, as *malus*, *pyrus*, *cratægus*, *sorbus*, *cydonia*, &c.

The plants of this family are generally astringent. The fruits of several chrysobalaneæ, which are chiefly tropical, are eaten. Those of the drupaceæ, such as the cherry, peach, nectarine, plum, &c., are well known. The leaves and kernels of this tribe yield prussic acid, and some of them are, for this reason, dangerous. The leaves of the sloe and the bird-cherry have been employed as a substitute for tea. The root of spiræa ulmaria, which is highly astringent, has been used as a tonic, and for dyeing black. The fruits of many fragariaceæ, as the strawberry, rasp, and brambles, are in common use. The root of *rubus villosus* affords an astringent decoction. *Brayera anthelminthicum*, is a remedy for tape-worm. *Agrimonia* and *poterium* are astringent. The fruit of *rosa canina*, and the petals of *rosa gallica*, are astringent, and have been employed in chronic diarrhœa and cases of debility. The fruits of most of the pomaceæ, as the apple, the pear, the quince, the medlar, are in common use. The numerous varieties of the rose afford highly prized garden flowers.

Homalineæ, Brown. The homalineæ are handsome evergreen shrubs or small trees, all natives of warm countries. Their leaves are alternate, petiolate, simple, furnished with caducous stipules. Their flowers are hermaphrodite, disposed in spikes, racemes, or panicles. Their calyx is monosepalous, having the tube short, conical, and adherent to the ovary, the limb divided into from ten to thirty lobes, of which the outer are larger and valvar, and the inner smaller and petalliform. The corolla is wanting. At the inner face, and most commonly towards the base of the inner sepals, are situated glandular and sessile appendages. The number of stamina varies: it is sometimes equal to that of the outer lobes of the calyx, and the stamina are opposite to them; at other times the stamina are more numerous and collected into bundles. The ovary is generally semi-inferior, with a single cell containing a great number of ovules attached to three or five parietal trophosperms. The styles, which are of the same number as the trophosperms, terminate each in a simple stigma. The fruit is sometimes dry, sometimes fleshy. The seeds have their embryo placed in a fleshy endosperm.

The genera are *homalium*, *napimoga*, *pineda*, *blackwellia*, *astranthus*, *nisa*, *myriantheia*, *asteropeia*, and *aristotelia*. Little is known of their properties.

Samydeæ, Ventenat. This family consists of exotic shrubs, growing in the warmest regions of the globe, and bearing alternate, distichous, simple, persistent leaves, commonly marked with translucid dots, and furnished with two stipules at their base. The flowers are axillar, solitary, or grouped. They have a calyx formed of five, more rarely of three or seven sepals, united together at their base, and sometimes forming a more or less elongated tube. The limb has more or less deep divisions, coloured on their inner surface. The corolla is always wanting. The stamina are of the same number

as the divisions of the calyx, or double, triple, or quadruple, and are inserted at their base. They are monadelphous, and some of them are occasionally sterile, and reduced to their filament, which becomes flat and downy. The ovary is free, with a single cell, containing a great number of ovules inserted on three or five parietal trophosperms. The style is simple, terminated by a capitulate or lobed stigma. The fruit is a unilocular capsule, opening by three or five valves, which bear upon the middle of their inner surface the seeds, enveloped in a more or less abundant coloured pulp. The seeds have a fleshy endosperm, in which is a very small heterotrope embryo; in other words, having its radicle opposite to the hilum or point of attachment of the seed.

This family is composed of the genera *samyda, anauringa, casearia,* to which may be added the genus *piparea* of Aublet.

Leguminosæ, Jussieu. This is a very natural family, in which are contained herbaceous plants, shrubs, or small trees, and trees often of colossal dimensions, natives of all parts of the world. Their leaves are alternate, compound or decompound, sometimes simple. Rarely the leaflets are abortive, and there only remains the petiole, which widens and forms a kind of simple leaf. At the base of each leaf are two persistent stipules. The flowers present a very diversified inflorescence. They are generally hermaphrodite. Their calyx is sometimes tubular, with five unequal teeth, sometimes with five more or less deep and unequal divisions. At the outside of the calyx, there are one or more bracteas, or sometimes a calyciform involucre. The corolla, which is sometimes wanting, is composed of five generally unequal petals, of which one, named the *standard,* is larger and superior; two named *wings* are lateral; and two inferior, and more or less coherent or united, forming the *keel.* Sometimes the corolla is formed of five equal petals. The stamina are generally ten in number, sometimes more numerous. Their filaments are usually diadelphous, rarely monadelphous, or entirely free, perigynous or hypogynous. The ovary is more or less stipitate at its base. It is generally elongated, inequilateral, with a single cell, containing one or more ovules attached to the inner suture. The style is somewhat lateral, often bent or curved, and terminated by a simple stigma. The fruit is always a legume. The seeds are generally destitute of endosperm.

This extensive family is composed of very numerous genera, which may be divided into three natural tribes:

1. Papilionaceæ: corolla formed of five unequal petals, constituting the irregular corolla named papilionaceous; ten stamina generally diadelphous, as *phaseolus, faba, lathyrus, robinia, glycine, astragalus, phaca,* &c.

2. Cassieæ: corolla generally formed of five regular petals; the ten stamina usually free, as *cassia, bauhinia, geoffræa,* &c.

3. Mimoseæ: containing the apetalous genera, furnished with a calyciform involucre; stamina very numerous and free, as *mimosa, acacia, inga,* &c.

The family of leguminosæ is very nearly allied to the rosaceæ, and, although at first sight it appears very easy to distinguish them, there are genera which form a kind of transition from the one family to the other.

The papilionaceæ are possessed of very diversified properties. The seeds of many species are used as food, such as the bean, the pea, &c., while those of others are purgative, emetic, or poisonous. Of the latter kind are those of the laburnum. The pulp of the tamarind, *ceratonia, siliqua, mimosa fagifolia,* and *cassia fistula,* is more or less purgative. Senna consists of the leaves of several species of cassia. Catechu is obtained from *acacia catechu.* Gum arabic is yielded by *acacia senegalensis* and other species; gum tragacanth by *astragalus creticus* and *verus. Myroxylon balsamiferum* affords the balsam of tolu; *copaifera officinalis,* copaiba balsam. Indigo is obtained from several species of indigofera; logwood is the wood of *hæmatoxylon campechianum;* sanders-wood that of *pterocarpus santalinus.* The tonkay-bean is the seed of *coumarouma odorata,* which owes its fragrance to a peculiar principle found also in the flowers of *melilotus officinalis.*

Terebinthaceæ, Jussieu. Consists of trees or shrubs, often lactescent or resinous, having alternate, generally compound leaves, destitute of stipules, and small hermaphrodite or unisexual flowers, usually disposed in racemes. Each of the flowers has a calyx of from three to five sepals, sometimes connected at their base, and united to the ovary, which is inferior, and a corolla, which is sometimes wanting, but is usually composed of a number of petals equal to the lobes of the calyx, and regular. The stamina are generally of the same number as the petals, more rarely double or quadruple: in the former case they alternate with the petals. The pistil is composed of from three to five carpels, sometimes distinct, sometimes more or less united, and surrounded at their base by a perigynous, annular disk. Sometimes some of the carpels are abortive, and there remains only one, from which spring several styles. Each carpel has a single cell, containing sometimes an ovule, supported upon the top of a filiform podosperm, which arises from the bottom of the cell, sometimes a reversed ovule, sometimes two reversed or collateral ovules. The fruits are dry or drupaceous, generally containing a single seed. The seed contains an embryo destitute of endosperm.

1. Anacardieæ or Cassuvieæ, containing the genera *anacardium*, *mangifera*, *pistacia*, &c.

2. Sumachineæ, to which belong the genera *rhus*, *mauria*, *davana*, &c.

3. Spondiaceæ, which comprehend the genera *spondias* and *poupartia*.

4. Burseraceæ, containing the genera *scica*, *boswellia*, *bursera*, *canarium*, &c.

5. Amyrideæ, *amyris*.

6. Connaraceæ, *connarus omphalobium*, *cnestis*, &c.

7. Juglandeæ, *juglans*, *carya*, &c.

This family is very closely related to the leguminosæ, from which it is distinguished, more especially by the absence of stipules. It is also allied to the Rhamneæ, which differ from it in having the ovary always inferior, and the stamina opposite to the petals.

The anacardieæ and sumachineæ abound in a resinous juice, which is often poisonous; but the fruit of several species, as well as of the spondiaceæ, is eatable. The burseraceæ, connaraceæ, and amyrideæ, are equally resiniferous. The walnut is the fruit of a species of juglans. Several fruits belonging to the same genus, are eaten in America.

Rhamneæ, Brown. (Part of the *rhamni* of Jussieu.) Trees or shrubs with simple, alternate, very rarely opposite leaves, furnished with two very small caducous, or persistent and spinous stipules. The flowers are small, hermaphrodite, or unisexual, axillar, solitary, or collected into sertules, fasciculi, &c., sometimes forming racemes or terminal sertules. The calyx is monosepalous, more or less tubular at its lower part, where it adheres to the ovary, which is inferior, having its limb dilated, with four or five valvar lobes. The corolla is composed of four or five very small, unguiculate petals, often involute and concave. The stamina, which are of the same number as the petals, are placed opposite to them, and are often embraced by them. The ovary is sometimes free, sometimes semi-inferior, or completely adherent, with two, three or four cells, containing each a single erect ovule. From the summit of the ovary generally proceed as many styles as it has cells. The base of the tube of the calyx, when the ovary is free, or the summit of the ovary when it is inferior, presents a glandular disk varying in thickness. The fruit is fleshy and indehiscent, or dry and opening into three cocca. The seed is erect, and contains in a fleshy, sometimes very thin endosperm, a homotrope embryo, having the cotyledons very broad and thin.

The principal genera are: *rhamnus*, *paliurus*, *ceanothus*, and *colletia*. The berries of several species are strong purgatives.

Celastrineæ, Brown. (Part of the *rhamni* of Jussieu) This family is composed of shrubs or trees with alternate or sometimes opposite leaves, and axillar flowers disposed in cymes. The calyx, which is slightly tubular at its base, has a limb with four or five spreading divisions, which are imbricated previous to expansion. The corolla is composed of four or five flat, slightly fleshy petals, destitute of claws, and inserted beneath the disk. The stamina alternate with the petals, and are inserted either upon the edge of the disk, or upon its upper surface. The disk is perigynal and parietal, surrounding the ovary. The ovary is free, with three or four cells, containing each one or more ovules, attached by a filiform podosperm to the inner angle of each cell, and ascending. The fruit, which is sometimes a dry drupe, is more commonly a capsule with three or four cells opening into three or four valves, each bearing a dissepiment upon the middle of its inner surface. The seeds, which are sometimes covered by a fleshy arillus, contain a fleshy endosperm in which is an axile and homotrope embryo.

Many of the species are ornamental shrubs; and the fruit and bark of others are purgative and emetic.

Aquifoliaceæ, De Candolle. (*Ilicineæ*, Ad. Brong.) Composed of shrubs with alternate or opposite, persistent, coriaceous, glabrous leaves, which are toothed, the teeth being sometimes spinous. The flowers are solitary, or variously grouped in the axillæ of the leaves. Each of them has a calyx with from four to six small and imbricated petals, and a corolla of an equal number of alternate petals, united at their base, and forming a monopetalous corolla, with deep and hypogynous divisions. The stamina, which are alternate with the lobes of the corolla, are inserted at its base. There is no appearance of a disk. The ovary is free, thick, truncate, with from two to six cells, each containing a single ovule suspended from the summit of the cell, and supported by a cup-shaped podosperm. The stigma is generally sessile and lobed. The fruit is always fleshy, containing from two to six indehiscent, woody or fibrous, and monospermous nucules. The embryo is small, homotrope, and placed towards the base of a fleshy endosperm.

Among the genera are *ilex*, *cassine*, *myginda*, &c.

Prinos verticillatus is astringent and tonic. The leaves of a species of ilex afford the famous Paraguay tea.

Euphorbiaceæ, Jussieu. The euphorbiaceæ are herbaceous plants, shrubs, or very large trees, which occur in all regions of the globe. Most of them contain a milky acrid juice. The leaves are usually alternate, sometimes opposite, accompanied with stipules, which are sometimes wanting. The flowers are unisexual, generally small, and are very diversified in their mode of inflorescence. The calyx is monosepalous, with three,

four, five, or six deep divisions, furnished internally with scaly and glandular appendages. The corolla is wanting in most genera, or is composed of petals sometimes distinct, sometimes united into a monopetalous corolla. It appears to be formed of abortive and sterile stamina. In the male flowers, there is a considerable number of stamina. More rarely the number is limited, or each stamen may be considered as a flower (as is admitted to be the case in the genus *euphorbia*). The stamina are free or monadelphous. The female flowers are composed of a free, sessile, or stipitate ovary, sometimes accompanied by a hypogynous disk. The ovary has usually three cells, each containing one or two suspended ovules. From the summit of the ovary arise three stigmas, which are generally sessile and elongated. The fruit is dry or slightly fleshy, and is composed of as many cocca, containing one or two seeds, as the fruit has cells. The cocca, which are internally bony, open elastically at their inner angle into two valves. They rest by their inner angle upon a central columella, which often continues after their dispersion. The seeds, which are externally crustaceous, and present a small fleshy caruncle, in the vicinity of their point of attachment, have a fleshy endosperm, in which is contained an axile and homotrope embryo.

Among the genera are the following: *euphorbia*, *mercurialis*, *ricinus*, *croton*, *jatropha*, *hura*, *buxus*, and *acalypha*.

All the plants of this family contain a milky juice which is acrid or poisonous. They abound in caoutchouc. Castor oil is obtained from the seeds of *ricinus communis*. The roots of several species are emetic, of others purgative. *Croton tiglium* affords an oil, which is a drastic purgative. In general, the family is characterised by acrid, narcotic, and poisonous qualities, residing in a volatile principle, which may be dissipated by heat.

URTICEÆ, Kunth. (*Urticeæ*, Jussieu; and *celtideæ*, Rich). This family consists of herbaceous plants, shrubs, or large trees, sometimes lactescent, with alternate leaves, generally furnished with stipules. Flowers unisexual, very rarely hermaphrodite, solitary, or variously grouped, and forming catkins, or collected in a fleshy involucre, which is flat, spreading, or pyriform and closed. In the male flowers there are a calyx formed of four or five sepals, which are distinct or united, and forming a tube, and four or five stamina, which are alternate, or very rarely opposite to the sepals. The female flowers have a calyx formed of from two to four sepals, or merely a scale, in the axilla of which they are placed. The ovary is free, with a single cell, containing a single pendent ovule, and surmounted, either by two long sessile stigmas, or by a single stigma, sometimes supported upon a style of variable length. The fruit is always composed of a crustaceous akenium, enveloped by the calyx, which sometimes becomes fleshy: at other times the involucre, which contains the female flowers, enlarges, as is remarked in the genera *ficus*, *dorstenia*, &c. The seed, besides its proper integument, is composed of a generally curved embryo, often contained within a more or less thin endosperm.

The family may be divided into three tribes:

1. CELTIDEÆ: flowers hermaphrodite; embryo without endosperm, as *ulmus*, *celtis*.

2. URTICEÆ: flowers unisexual; fruits distinct; embryo enclosed in a thin endosperm, as *urtica*, *parietaria*, *humulus*, *cannabis*, *morus*.

3. ARTOCARPEÆ: flowers unisexual; fruits collected in a flat or pyriform fleshy involucre; embryo furnished with an endosperm, as *dorstenia*, *ficus*, &c.

The bark of the elms is bitter and astringent. The uses of hemp are well known. Its leaves are narcotic. The urticeæ or nettles, are remarkable for their stinging propensities. The common hop contains a bitter and narcotic principle, which is used in the manufacture of ale and porter. The artocarpeæ are extremely heterogenous as to their properties, the bread-fruit, the mulberry, and the fig, being the products of certain species, while others yield the most deadly poisons. Caoutchouc is also yielded by several species of this family.

MONIMIÆ, Jussieu. (*Atherospermeæ*, Brown) Composed of trees or shrubs, natives of America and New Holland, with opposite leaves, destitute of stipules and unisexual flowers. The flowers present a globular or calyciform involucre, the divisions of which are disposed in two series. In the former case, the involucre has only some small teeth at its summit; and, in the male flowers, bursts and opens into four deep and pretty regular lobes, the whole upper surface of which is covered with stamina, having short filaments, and each forming a male flower. In the second case (*ruizia*), the stamina line only the lower and tubular part of the involucre; the filaments are longer; and, towards their lower part, bear on each side a pedicellate tubercle, similar to that which is observed in the same place in the Laurineæ. The female flowers are composed of an involucre precisely similar to that of the male flowers. In the genera *monimia*, and *ruizia*, there are at the bottom of this involucre, eight or ten erect pistils, perfectly distinct from each other, and intermixed with hairs. In *ambora*, these pistils are very numerous, entirely immersed in the substance of the walls of the involucre, the only part that is free and visible being their summit, which is a small conical mammilla, and forms the real stigma. Each of these pistils is unilocular, and contains a single ovule suspended from its sum-

mit. In the genera *ambora* and *monimia*, the involucre is persistent; it even enlarges greatly, and becomes fleshy in the first of these genera. The fruits, which in *ambora* are contained in the substance of the walls of the involucre, are so many small unilocular one-seeded drupes. The seed is composed of a rather thin proper integument, covering a very thick fleshy endosperm, in the upper part of which is placed an embryo which has the same direction as the seed.

The genera have been divided into two tribes:

1. Amboreæ: anthers opening by a longitudinal groove; seeds reversed. *Ambora, monimia, ruizia.*

2. Atherospermeæ: anthers opening from the base to the summit, by means of a valve; seeds erect. *Pavonia, atherosperma, citrosma.*

The monimiæ are much allied to the urticeæ, with which several of their genera were formerly united; but they differ from them especially in having their seeds furnished with a very large endosperm, and in having their ovule pendent and not erect. The same character also separates them from the laurineæ, which they approach in the structure of their stamina in the tribe of atherospermeæ. The properties of the species are little known.

Salicineæ, Rich. This family is composed of the genera *salix* and *populus*, and contains large trees, with alternate, simple leaves, furnished with caducous stipules. The flowers are unisexual, and disposed in cylindrical or egg-shaped catkins. The male flowers are composed of from two to twenty stamina, placed in the axilla of a scale, or upon its upper surface. The female flowers consist of a fusiform pistil, terminated by two bipartite stigmas, situated in the axilla of a scale, and sometimes accompanied at their base by a cup-shaped calyx. The ovary has one or two cells containing a considerable number of erect ovules, attached to the bottom of the cell, and the base of two parietal trophosperms. The fruit is a small, elongated capsule, with one or two cells, containing several seeds surrounded by long silky hairs, and opening by two valves. The embryo is erect, homotrope, destitute of endosperm.

The salicineæ, a dismemberment of the amentaceæ, form a group which is very distinct in the form of their fruit.

This family affords some useful and ornamental trees. The bark is generally astringent and tonic. It is employed in tanning, and that of some species, especially of *salix helix*, has of late acquired some celebrity as a substitute for Peruvian bark in fevers.

Myriceæ, Rich. (*Causuarineæ*, Mirbel.) With the exception of the genus causuarina, which, in its general aspect, resembles a gigantic *equisetum*, the myriceæ are trees or shrubs, with alternate or sparse leaves, with or without stipules. Their flowers are always unisexual, and most commonly diœcious. The male flowers, disposed in catkins, are composed of one or more stamina, often collected upon a branched androphorum, and placed in the axilla of a bractea. The female flowers, which are also in catkins, are solitary and sessile in the axilla of a bractea longer than themselves. Each flower is composed of a lenticular ovary, containing a single erect ovule. The style is very short, and surmounted by two long subulate, glandular stigmas. Externally of the ovary are two, three, or a greater number of hypogynous, persistent scales, which are sometimes united to the fruit. The fruit is a kind of small monospermous, indehiscent nut, sometimes membranous, and winged upon its margins. The seed which it contains is erect; its integument immediately covers a large embryo, having a direction entirely the reverse of that of the seed.

This family, which is formed of genera that are sometimes placed in the family of amentaceæ, is allied to the celtideæ and betulineæ, but differs from the former in its flowers being in catkins, and always unisexual, and its erect ovule, and from the latter in its unilocular ovary, and its embryo destitute of endosperm.

Their properties are generally aromatic and resinous. A wax is obtained from the berries of *myrica cerifera.*

Betulineæ, Rich. Composed of trees with simple, alternate leaves, accompanied at their base by two stipules. Flowers unisexual, disposed in scaly catkins. In the male catkins, each scale, which is sometimes formed of several scales united, bears two or three flowers which are naked, or have a calyx with three or four deep divisions. The number of stamina is very variable in each flower. The female catkins are egg-shaped, or cylindrical, and scaly. At the inner base of each scale are from one to three naked, sessile flowers, presenting a free, compressed ovary, with two cells, containing each a single ovule attached towards the upper part of the dissepiment, and surmounted by two elongated, cylindrical and glandular stigmas. The fruit is a scaly cone, the woody or merely cartilaginous scales, bear at their base one or two small unilocular akenia, which are monospermous, through abortion, and membranous on the edges. The seed is composed of a large embryo without endosperm, having the radicle superior.

The two genera *alnus* and *betula* constitute this family, which differs from the salicineæ in having its ovary furnished with two monospermous cells, its indehiscent fruits, and its seeds, destitute of the long hairs which cover those of the salicineæ. The myraceæ are also closely allied to the betulineæ, but their ovary is always unilocular, and their ovule erect. This family, like

the last, is frequently included in the *amentaceæ*.

The birch and alder are well known winter trees. Their bark is astringent; that of the birch *(betula alba)* and others is used for tanning. The juice of the same plant is sweetish, flows in considerable abundance from a cut in the bark, and is made into a kind of wine.

CUPULIFERÆ, Rich. (Part of the *amentaceæ* of Jussieu.) Containing trees with alternate, simple leaves, furnished with caducous stipules at their base. The flowers are always unisexual, and almost always monœcious. The male flowers form cylindrical, scaly catkins. Each flower presents a simple, trilobate, or calyciform scale, on the upper face of which are attached from six to a greater number of stamina, without any appearance of pistil. The female flowers are generally axillar, sometimes solitary, sometimes grouped into capitula or catkins. In all cases, each of them is covered, in part or in whole, by a scaly cupula, and presents an inferior ovary, having its limb not very prominent, and forming a small irregularly toothed rim. From the summit of the ovary rises a short style, which is terminated by two or three subulate or flat stigmas. This ovary has two, three, or a greater number of cells, each containing one or two suspended ovules. The fruit is always an acorn, generally unilocular, often monospermous by abortion, always accompanied by a cupule, which sometimes covers the fruit entirely like a pericarp, as in the chestnut and beech. The seed is composed of a very large embryo, destitute of endosperm.

This family, which is composed of genera frequently placed in the family of amentaceæ, comprehends the genera *quercus*, *corylus*, *carpinus*, *castanea*, and *fagus*. It has some affinity to the coniferæ and betulineæ; but the former are sufficiently distinguished by their general aspect, the structure of their female flowers, and the endosperm of their embryo, and the latter by their female flowers being disposed in cones, their simple ovary, &c. The other families which have also been formed of the amentaceæ, such as the salicineæ and myraceæ, are more particularly distinguished from the cupuliferæ by having the ovary free.

The species consist of some of our most useful timber trees; and the properties are generally astringent, stomachic, and tonic. The bark of *quercus robur* is used for tanning in this country, and of *q. tinctoria* in America. The seeds abound in fixed oil, and are used as food. Galls, which are employed in making ink, are excrescences of a species of oak. Cork is the bark of another species, *q. suber*.

CONIFERÆ, J. Rich. This useful family is composed of trees of the pine and fir kind. Their leaves, which are coriaceous and stiff, are persistent in all the species, excepting the larch and gingo. They are sometimes linear, subulate, aggregated in bundles of from two to five, and accompanied at the base by a small scariose sheath; or they are in the form of imbricated or lanceolate scales. The flowers are always unisexual, and generally disposed in cones or catkins. The male flowers consist essentially each of a stamen, sometimes naked, sometimes accompanied by a scale in the axilla, or on the lower surface of which it is placed. Not unfrequently several stamina are united together by their filaments, and their anthers, which are unilocular, remain distinct, or unite together. The inflorescence of the female flowers is very variable, although they generally form cones or scaly catkins. Thus they are sometimes solitary, terminal or axillar, or they are collected in a fleshy or dry involucre. Each of these flowers has a monosepalous calyx, adherent to the ovary, which is in part, or entirely inferior. Its limb, which is sometimes tubular, is entire, or has two divaricate lobes, glandular at their inner surface, and which have been generally considered as two stigmas. The ovary is one-celled, and contains a single ovule. At its summit it commonly presents a small cicatrix, which is the true stigma. Sometimes the female flowers are erect in the axilla of the scales, or in the involucre in which they are placed; sometimes they are reversed and united two and two, by one of their sides, to the inner surface, and towards the base of the scales which form the cone. The fruit is generally a scaly cone or a galbule of which the scales are sometimes fleshy, unite and represent a kind of berry, as in the junipers. Each particular fruit, that is, each fecundated pistil, has a pericarp which is frequently crustaceous, sometimes furnished with a membranous, marginal wing. The proper tegument of the seed is adherent to the pericarp, and covers a kernel composed of a fleshy endosperm, containing an axile and cylindrical embryo, of which the radicle is united to the endosperm, and its cotyledonary extremity divided into two, three, four, and even as many as ten cotyledons.

The elder Richard, in his splendid work on the coniferæ, divides the family into three orders thus:

1. TAXINEÆ: female flowers distinct from each other, attached to a scale, or in a cupula; fruit simple, as *podocarpus*, *dacrydium*, *taxus*, *salisburia*, *phyllocladus*, *ephedra*.

2. CUPRESSINEÆ: female flowers erect, collected several together in the axilla of scales which are not numerous, forming a galbule, which is sometimes fleshy, as *juniperus*, *thuya*, *callitrix*, *cupressus*, *taxodium*.

3. ABIETINEÆ. To this order belong all the genera in which the female flowers are reversed,

and which have for their fruit a true scaly cone, as *pinus, abies, cunninghamia, araucaria*, &c.

The coniferæ are found in large forests, in the north of Europe, and America, and are most important as timber trees, for all purposes. Some species, as *dammara australis* and *pinus lambertiana*, are said to attain a height of 200 feet or more. Oil of turpentine, resin, and pitch are obtained from *pinus sylvestris, abies pectinata*, and other species. Spruce-beer is made from an extract of the branches of *abies canadensis.* The bark of the larch is said to equal that of the oak for tanning. *Juniperus sabina* is stimulant and diuretic. The berries of *juniperus communis*, which are also diuretic, are employed in the manufacture of gin. The berries of the yew are said to be poisonous, and its leaves are dangerous to cattle.

Cycadeæ, Rich. The cycadeæ, which are composed of only two genera, *cycas* and *zamia*, are extra-European plants, having the habit of palms. Their leaves, which are collected at the top of the stipe, are pinnate and rolled up in the form of a crosier previous to their development, as in the ferns. The flowers are always diœcious. The male flowers form catkins or cones, which are sometimes very large, and which are composed of spathulate scales, covered at their lower surface by very numerous stamina, which must be considered as so many male flowers. The inflorescence of the female flowers is different in the two genera *cycas* and *zamia.* In the former, a long, acute, spathulate spadix, toothed on the edges, bears at each tooth a female flower, immersed in a small cavity. *Zamia* has its female flowers also in a cone, and its scales, which are thick and peltate, bear each at their lower surface two reversed female flowers. These flowers are composed of a globular calyx, perforated by a very small aperture at its summit, and applied upon the ovary, which is in part adherent at its base. The ovary is unilocular and contains a single ovule; it is terminated at its summit by a nipple-like stigma. The fruit is a kind of nut formed by the calyx, which sometimes is slightly fleshy. The pericarp is generally thin, crustaceous and indehiscent, and adheres to the proper integument of the seed. The kernel is composed of a fleshy endosperm, containing an embryo with two unequal cotyledons, sometimes adhering together, and with the radicle united to the endosperm.

However superficially one may compare the structure of the male flowers, and especially of the female flowers, of the cycadeæ with that of the coniferæ, he will be struck with the very great similarity that exists between the two families, and cannot fail to adopt the opinion of the elder Richard, who places them beside each other. In fact, in both, the male flowers consist each of a monospermous perianth, and a semi-inferior ovary, with a single cell and a single ovule. The fruit and the seed have the same organization. It is true that the habit or general aspect is entirely different in the two families, the cycadeæ resembling the palms, and the internal structure of the stem being that of the monocotyledons. But this character ought not to be sacrificed to the important resemblances which exist in the organization of the flowers of the cycadeæ and coniferæ, whereby their true place is evidently beside each other.

A kind of sago is prepared from the central parenchyma of *cycas circinalis.*

CHAP. LVI.

FOSSIL PLANTS.

The history of those plants found imbedded in the earth's strata, and which formerly flourished on its surface, forms an interesting link in the chain of vegetable being. Unfortunately, from the mode in which the remains of these vegetable productions have been preserved, it in most cases happens that only conjectures can be formed regarding their peculiar characters. Most commonly, only pieces of the trunks and branches, or fragments of the bark, or the leaves and fruits, or pieces of the stems and roots, and rarely or never the delicate inflorescence being preserved for our inspection. Yet, from these fragments, it is wonderful how much has already been ascertained of the form, and even minute structure of many of those ornaments of a former state of things on the earth's surface.

The number of fossil plants as yet known does not much exceed five hundred. Like the corresponding fossil animals, these plants generally are found to belong to existing classes and families of plants, yet the species and even genera are specifically different; while in not a few cases, totally new orders and genera have been discovered, serving, from their structure, to fill up blanks and chasms in the chain of existing vegetable forms. Of this description are the *Lepidodendrons, Stigmariæ, Sigillariæ*, and others. Vegetable remains, like animal, begin to make their appearance in the lower beds of the secondary series of rocks, and as these rocks have decidedly been accumulated and formed in the bed of the ocean, we accordingly find that marine fuci are more or less plentifully scattered among their successive layers; while in other situations of the same strata, where the original deposit has been formed by rivers or lakes, land plants are accumulated in abundance. One great and important deposit of ancient vegetation has formed the various coal-fields found in different parts of the world; and it is important to remark,

that in whatever latitude or region of the globe such coal deposits exist, the vegetables entering into their composition have, so far as investigation into the subject has gone, been found identical in character. Thus, in America, New Holland, India, and Europe, the genera, and for the most part the species of fossiliferous plants of the carbonaceous series, have been found the same. This circumstance, so different from what occurs with regard to the existing vegetation, would lead to the conclusion, that in certain remote periods of the earth's history a more uniform distribution of plants, and consequently of temperature, existed.

As the study of fossil botany is yet almost in its infancy, and as every year is disclosing new species, it may be expected that the numerical amount of plants of the ancient strata may yet greatly increase. Yet it must be borne in mind, that the fragile nature of innumerable species, must have entirely prevented their coming down to our times in any degree of preservation, and thus, that we are not hastily to conclude that the ancient flora was less numerous than the modern. From some interesting experiments of Professor Lindley, it would appear also, that certain kinds of plants resist decay and destruction much more effectually than others. This botanist, having immersed in a tank of fresh water upwards of 170 different species of plants, including representations of all those which are either constantly present in the coal measures, or not at all to be found there, ascertained, after an interval of two years:

1st. That during this period the leaves and bark of most dicotyledonous plants are wholly decomposed, and that of those which do resist decomposition, the greater part are *coniferæ* and *cycadeæ*.

2d. That monocotyledons are more capable of resisting the action of water, particularly palms and scitamineous plants, but that grasses and reeds perish.

3d. That fungi, mosses, and all the lowest forms of vegetation, disappear.

4th. That ferns have a great power of resisting water, if gathered in a green state, all those submitted to experiment retaining their form distinctly, while their fructification was completely obliterated.

These results must materially influence all speculations regarding the probable distribution of the extinct flora, and accordingly in enumerating those plants which are found chiefly to characterise the successive geological formations, it must be borne in mind that we find those only which have from their nature resisted the destructive agencies in the respective strata, while many others, their cotemporaries, must be presumed to be entirely lost to us. From our present knowledge, it would appear, that in the lowermost fossiliferous strata, marine fuci are most common. That in the next formation, ferns, equisetaceæ, coniferæ, and plants intermediate between them and the lycopodiaceæ prevail, and that in the succeeding strata, ferns, cycadeæ, and coniferæ, with a few liliaceæ, are common; while in the tertiary beds, species of dicotyledonous plants, bearing a close relation to existing species, make their appearance.

Of the trees which pervade all the fossiliferous strata, the coniferæ and palm tribes are by far the most common.

The following table exhibits a classified view of the present state of fossil botany.*

DICOTYLEDONOUS PLANTS.

NATURAL FAMILY.—NYMPHÆACEÆ.

Genus 1. *Nymphea.* One species in the upper fresh water formation.

LAURINEÆ.

Genus 2. *Cinnamomum.* One species in the tertiary fresh water formation of Aix.

LEGUMINOSÆ.

Genus 2. *a. Phaseolites.* Leaves compound, unequally pinnate, leaflets entire, disarticulating, with nearly equal reticulated veins.

One species in the tertiary fresh water formation of Aix.

ULMACEÆ.

Genus 3. *Ulmus.* One species in tertiary formations.

CAPULIFERÆ.

Genus 4. *Carpinus.* One species in lignite of tertiary beds.

Genus 5. *Castaneæ.* One species in tertiary formations.

BETULINEÆ.

Genus 6. *Betula.* One species in the lignite of tertiary beds.

SALICINEÆ.

Genus 7. *Salix.* One species in tertiary formation.

Genus 8. *Populus.* One or two species in tertiary formation.

MYRICEÆ.

Genus 9. *Comptonia.* One species in the lignite of tertiary formations, and probably one in the lower fresh water formations.

JUGLANDEÆ.

Genus 10. *Juglans.* Three species in the tertiary strata, one in upper bed of new red sandstone.

EUPHORBIACEÆ.

Genus 11. *Stigmaria,* (*Variolaria* of Sternberg, *Mamillaria* of Ad. Brogniart, *Ficoiditis,* Artis.) Stem originally succulent, marked externally by roundish tubercles, surrounded by a hollow, and arranged in a direction more or less spiral, having internally a distinct woody axis, which communicates with the tubercles by woody processes. Leaves arising from the tubercles succulent, entire, and veinless, except in the centre, where there is some trace of a midrib.

Five or six species in the coal formation, and one in the oolitic formation.

* Lindley and Hutton, Brongniart, &c.

ACERINEÆ.

Genus 12. *Acer.* One or two species in the tertiary beds.

CONIFERÆ.

The wood only known.

Genus 13. *Pinites.* Axis composed of pith wood in concentric circles, bark and medullary rays, but with no vessels, walls of the woody fibre reticulated.

Three species in coal formation.

Genus 14. *Araucaria.* Axis composed of pith wood in concentric circles, bark and medullary rays.

One or two species in coal measures; one in lias.

Fruit or branches, and leaves, only known.

Genus 15. *Pinus.* Leaves growing two, three, or five in the same sheath; cones composed of imbricated scales, which are enlarged at their apex into a rhomboidal disk.

Nine species in the tertiary strata.

Genus 16. *Abies.* Leaves solitary, inserted in eight rows in a double spine, often unequal in length and distichous; cones composed of scales, without a rhomboidal disk.

One species.

Genus 17. *Taxites.* Leaves solitary, supported on a short petiole, articulated and inserted in a single spine, not very dense, distichous.

Five species in tertiary beds.

One species in oolitic formation.

Genus 18. *Podocarpus.* Leaves solitary, much larger than in the last genus, sharp, pointed, flat, with a distinct midrib.

One species in the tertiary formation of Aix.

Genus 19. *Voltiza.* Branches pinnated, leaves inserted all round the branches, sessile, slightly decurrent or dilated at the base, and almost conical, often distichous. Fruit forming spikes or loose cones composed of distant imbricated scales, which are more or less deeply three-lobed.

Four species in the new red sandstone.

Genus 20. *Juniperites.* Branches arranged irregularly, leaves short, obtuse, inserted by a broad base, opposite, decussate, and arranged in four rows.

Three species in the tertiary beds.

Genus 21. *Cupressites.* Branches arranged irregularly; leaves inserted spirally in six or seven rows, sessile, enlarged at their base; fruit consisting of peltate scales, marked with a conical protuberance in the centre.

One species in the new red sandstone.

Genus 22. *Thuja.* Branches alternate, regularly arranged upon the same plane; leaves opposite, decussate in four rows; fruit composed of a small number of imbricated scales, terminated by a disk, which has near its upper end a more or less acute and sometimes recurved point.

Three or four species in the tertiary formations.

Genus 23. *Thuytes.* Branches as in thuja; fruit unknown.

Several species in oolite.

Doubtful Coniferæ.

Genus 24. *Brachyphyllum.* Branches pinnated, disposed on the same plane without regularity; leaves very short, conical, almost like tubercles, arranged spirally.

One species in the lower oolite.

Genus 25. *Sphenophyllum.* Branches deeply furrowed; leaves verticillate, wedge-shaped with dichotomous veins.

Eight species in the coal formation.

CYCADEÆ.

Leaves only known.

Genus 26. *Cycadites.* Leaves pinnated, leaflets linear, entire, adhering by their whole base, having a single thick midrib, no secondary veins.

One species in the grey chalk.

Genus 27. *Zamia.* Leaves pinnated, leaflets entire or toothed at the extremity, pointed, sometimes enlarged, and encircled as it were at their base, attached only by the midrib, which is often thickened; veins fine, equal, all parallel, or scarcely diverging.

Fifteen species in the lias and oolite.

Genus 28. *Pterophyllum.* Leaves pinnated; leaflets almost equally broad each way, inserted by the whole of their base, truncated at the summit; veins fine, equal, simple, but little marked, all parallel.

Three species in the variegated marle of the lias; three species in the sandstone of the lias; one species in the quader sandstein; one species in the lower oolitic beds.

Genus 29. *Nilsonia.* Leaves pinnated; leaflets approximated, oblong, more or less elongated, rounded at the summit, adhering to the rachis by the whole of their base, with parallel veins, some of which are much more strongly marked than others.

Two species in the sandstone of the lias.

Stems only known.

Genus 30. *Cycadesdeæ.* Buckland (Mantellia, *Brong.*) Stem roundish or oblong, covered with densely imbricated scales, which are scored at their apex.

Two species in the Portland stone.

DICOTYLEDONOUS PLANTS OF DOUBTFUL AFFINITY.

Genus 31. *Phyllotheca.* Stem simple, straight, articulated, surrounded at equal distances by sheaths, having long linear leaves, which have no distinct midrib.

One species in the coal formation.

Genus 32. *Annularia.* (Bornia, *Sternberg.*) Stem slender, articulated, with opposite branches springing from above its leaves; leaves verticillate, flat, usually obtuse, with a single midrib united at the base, of unequal length.

Six or seven species in the coal formation.

Genus 33. *Asterophyllites.* (Bornia and Bruckmannia, *Sternberg.*) Stem scarcely tumid at the articulations, branched; leaves verticillate, linear, acute, with a single midrib, quite distinct at the base; fruit, a one-seeded ovate, compressed, nucule, bordered by a membranous wing, and emarginate at the apex.

Twelve species in the coal formation; one species in the transition beds.

This is probably an extremely heterogeneous assemblage, comprehending nearly all fossils, with narrow veinless verticillate leaves that are not united in a cup at their base.

Genus 34. *Bechira.* Stem branched, jointed, tumid at the articulations, deeply and widely furrowed; leaves verticillate, very narrow, acute, ribless.

One species in the coal formation.

MONOCOTYLEDONOUS PLANTS.

MARANTACEÆ.

Genus 35. *Cannophyllites.* Leaves simple, entire, traversed by a very strong midrib; veins oblique, simple, parallel, all of equal size.

One species in a bed of coal supposed of more recent origin than the old coal formation.

ASPHODELEÆ.

Stems only known.

Genus 36. *Bucklandia.* Stem covered by reticulated fibres, giving rise to imbricated leaves which are not amplexicaul, and the petioles of which are distinct to their base.

One species in Stonesfield slate. Dr Buckland suggests the possibility of this being the omentum of a cycadeous plant.

Genus 37. *Clathraria.* Stem composed of an axis, the surface of which is covered by reticulated fibres, and of a bark formed by the complete union of the bases of petioles, whose insertion is rhomboidal.

One species in the green sand.

Leaves only known.

Genus 38. *Convallarites.* Leaves verticillate, linear, with parallel slightly marked veins; stem straight or curved.

Two species in the variegated sandstone.

Flowers only known.

Genus 39. *Antholithes.* One species in the tertiary beds.

SMILACEÆ.

Genus 40. *Smilacites.* Leaves heart-shaped or hastate, with a well defined midrib, and two or three secondary ribs on each side, parallel to the edge of the leaf; veins reticulated.

One species in the lower fresh water formation.

PALMÆ.

Stems only known.

Genus 41. *Palmacites.* Stems cylindrical, simple, covered by the bases of petiolated leaves, petioles dilated and amplexicaul.

One species in the lower beds of the London clay formation.

Leaves only known.

Genus 42. *Flabellaria.* Leaves petiolated, flabelliform, divided into linear lobes, plaited at their base.

One species in the plastic clay formation.

One in the lower fresh water formation.

One in the London clay.

One in the coal formation.

Genus 43. *Phœnicites.* Leaves petiolated, pinnated; leaflets linear, united by pairs at the base, their veins fine, and little marked.

One species in the tertiary formations.

Genus 44. *Næggerathia.* Leaves petiolated, pinnated; leaflets obovate, nearly cuneiform, applied against the edges of the petiole, toothed towards their apex with fine diverging veins.

Two species in the coal measures.

Genus 45. *Zeugophyllites.* Leaves petiolated, pinnated; leaflets opposite, oblong, or oval, entire, with a few strongly marked ribs, confluent at the base and summit, all of equal thickness.

One species in the coal formation.

Fruit only known.

Genus 46. *Cocos.* Fruit ovate, slightly three-cornered, marked with three orifices near the base.

Three species in the tertiary formation.

FLUVIALIS.

Genus 47. *Zosterites.* Leaves oblong or linear, marked with a small number of equal veins, which are at a marked distance from each other, and are not connected by transverse veins.

Four species in the lower greensand formation.

One in the lias.

Two species in the upper fresh water formation.

Genus 48. *Caulinites.* (Amphytoites, *Desm.*) Stem branched, bearing semi-annular, or nearly annular scars of leaves, alternate in two opposite rows, marked with little equal dots.

One species in the London clay.

MONOCOTYLEDONOUS PLANTS OF DOUBTFUL AFFINITY.

Stems only known.

Genus 49. *Endogenites.* This comprehends all fossil endogenous stems that do not belong to any of the genera characterised separately. It is a mere provisional assemblage of objects to be further investigated.

Several species from the tertiary strata.

Genus 50. *Culmites.* Stems articulated with two or more scars at the joints.

Three species in the tertiary beds.

Genus 51. *Sternbergia.* (Columnaria, *Sternberg.*) Stem taper, slender, naked, cylindrical, terminating in a cone marked by transverse furrows, but with no articulations; slight remains of a fleshy cortical integument.

Three species in the coal formation.

Leaves only known.

Genus 52. *Poacites.* All monocotyledonous leaves, the veins of which are parallel, simple, of equal thickness, and not connected by transverse bars.

Several species in the coal formation.

Genus 53. *Phyllites.* (Potamophyllites, *Brong.*) All monocotyledonous leaves, the veins of which are confluent at the base and apex, and connected by transverse lairs or secondary veins.

One species in the lower fresh water formation.

Fruits only known.

Genus 54. *Trigonocarpum.* Two species in coal formation.

Genus 55. *Amomocarpum.* One species in tertiary beds.

Genus 56. *Musocarpum.* Two species in coal formation.

Genus 57. *Pandanocarpum.* One species in the tertiary strata.

FLOWERING PLANTS OF UNCERTAIN CLASSES.

Genus 58. *Æthophyllum.* Stem simple; leaves alternate, linear, ribless, not sheathing, having at the base two smaller linear leaflets, or, perhaps, stipules; inflorescence spiked; spikes ovate; flowers numerous, with a subcylindrical tube or inferior ovarium, and a bilabiate perianthium, with subulate segments.

One species in the new red sandstone. M. Brongniart refers this to the monocotyledons.

Genus 59. *Echinostachys.* Inflorescence an oblong spike, beset on all sides with sessile, contiguous, subconical flowers or fruits.

One species in the new red sandstone.

Genus 60. *Palæoxyris.* Inflorescence, a terminal fusiform spike, with appressed closely imbricated

scales. Its external portion, when it is not covered by scales, rhomboidal, concave in the middle.

One species in the new red sandstone.

CRYPTOGAMIC PLANTS.

EQUISETACEÆ.

Genus 61. *Equisetum.* Stems articulated, surrounded by cylindrical sheaths, which are regularly tooth-letted, and pressed close to the stem.

One species in the London clay.
One in the variegated marls of the lias.
One in the lower oolite and lias.
Two in the coal formation.

Genus 62. *Calamites.* Stems jointed regularly and closely furrowed, hollow, divided internally at the articulations by a transverse diaphragm, covered with a thick cortical integument; leaves verticillate, very narrow, numerous, and simple.

Two species in the transition beds.
Several species in the coal formation.
Two species in the new red sandstone.
Two in the new red sandstone and coal formation.

Genus 63. *Pachypteris.* Leaves pinnated or bipinnated; leaflets entire, coriaceous, ribless, or one ribbed, contracted at the base, but not adherent to the midrib.

Two species in the inferior oolite.

Genus 64. *Sphenopteris.* Leaves bi-tripinnatifid; leaflets contracted at the base, not adherent to the rachis, lobed, the lower lobes largest, diverging, somewhat palmate; veins bipinnate, radiating as it were from the base.

One species in the sand below the chalk.
Two species in the new red sandstone.
Five species in the oolite.
Twenty-eight species in the coal formation.

Genus 65 *Cyclopteris.* Leaves simple, entire, somewhat orbicular; veins numerous, radiating from the base, dichotomous, equal, midrib wanting.

Four species in the coal formation.
One species in the transition rocks.
One in the oolite.

Genus 66. *Glossopteris.* Leaves simple, entire, somewhat lanceolate, narrowing gradually to the base, with a thick vanishing midrib; veins oblique, curved, equal, frequently dichotomous, or sometimes anastomosing and reticulated at the base.

Two species in the coal formation.
One in the oolite.
One in the lias.

Genus 67. *Neuropteris.* Leaves bipinnate or rarely pinnate; leaflets usually somewhat cordate at the base, neither adhering to each other, nor to the rachis by the whole base, only by the middle portion of it; midrib vanishing at the apex; veins oblique, curved, very fine, dichotomous; *fructification*, sori-lanceolate, even, covered with an indusium, arising from the veins of the apex of the leaflets, and often placed in the bifurcations.

Twenty-four species in the coal formation.
Three in the new red sandstone.
One in the anthracite of Savoy.
One in the Muschel kalk.

Genus 68. *Odontopteris.* Leaves bipinnated; leaflet membranous, very thin, adhering by all their base to the rachis, with almost no midrib; veins equal, simple, or forked, very fine, most of them springing from the rachis.

Five species in the coal formation.

Genus 69. *Anomopteris.* Leaves pinnated; leaflets linear, entire, somewhat plaited transversely at the veins, having a midrib; veins simple, perpendicular, curved; *fructification* arising from the veins uncertain as to form, perhaps, dot-like, and inserted in the middle of the veins, or perhaps, linear, attached to the whole of a vein, naked, as in *meniscia*, or covered by an indusium, opening inwardly.

One species in the new red sandstone.

Genus 70. *Tæniopteris.* Leaves simple, entire, with a stiff thick midrib; veins perpendicular, simple or forked at the base; *fructification* dot-like.

Three species in the lias and oolite.

Genus 71. *Pecopteris.* Leaf once, twice, or thrice pinnate; leaflets adhering by their base to the rachis, or occasionally distinct; midrib running quite through the leaflet; veins almost perpendicular to the midrib, simple, or once or twice dichotomous.

Sixty species in the coal formation.
Ten in the oolite.
Two in the lias.
One in the beds above the chalk.

Genus 72. *Lonchopteris.* Leaf many times pinnatifid; leaflets more or less connate at the base, having a midrib; veins reticulated.

Two species in the coal formation.
One in the greensand.

Genus 73. *Clathropteris.* Leaf deeply pinnatifid; leaflets having a very strong complete midrib; veins numerous and simple, parallel, almost perpendicular to the midrib, united by transverse veins, which form a net work of square meshes upon the leaf.

One species in the lias.

Genus 74. *Schizopteris.* Leaf linear plane, without midrib, finely striated, almost flabelliform, dividing into several lobes which are linear and dichotomous, or rather irregularly pinnated and erect; lobes dilated, and rounded towards the extremity.

One species in the coal formation.

Genus 75. *Felicites.* This comprehends all that are not referable to the preceding genera.

One species in the new red sandstone.
Two species in the variegated marl of the lias.

Genus 76. *Caulopteris.* Stem cylindrical, closely marked by large, oblong, convex, uneven scars, wider than the tortuous depressed spaces that separate them.

Two species in the coal formation.
One in the new red sandstone.

Genus 77. *Otopteris.* Leaf pinnated; leaflets originating obliquely from the side of the leaf stalk, auricled, attached by about half their base, destitute of all trace of midrib; veins of equal size, very closely arranged, diverging from their point of origin, and dividing dichotomously at a very acute angle.

Three or four species from lias, oolite, and new red sandstone.

LYCOPODIACEÆ.

Genus 78. *Lycopodites.* Branches pinnated; leaves inserted all round the stem in two opposite

rows, not leaving clear and well defined scars.

Ten species in the coal formation.
One in the inferior oolite.
One in the lias sandstone.
One in the marl below the chalk.

Genus 79. *Selaginites*. Stems dichotomous, not presenting regular elevations at the base of the leaves, even near the lower end of the stems; leaves often persistent, enlarged at their base.

Two species in the coal formation.

Genus 80. *Lepidodendron*. Stems dichotomous, covered near their extremities by simple linear or lanceolate leaves, inserted upon rhomboid areolæ, lower part of the stems leafless, areolæ longer than broad, marked near their upper part by a minute scar, which is broader than long, and has three angles, of which the two lateral are acute, the lower obtuse, the latter sometimes wanting.

Several species in the coal formation.

Genus 81. *Ulodendron*. Stem covered with rhomboidal areolæ, which are broader than long, scars large, few, placed over above the other, circular, composed of broad cuneate scales, radiating from a common centre, and indicating the former presence of organs that were, perhaps, analogous to the cones of coniferæ.

Two species in the coal measures, with, perhaps, another genus Bothrodendron.

Genus 82. *Lepidophyllum*. Stem unknown; leaves sessile, simple, entire, lanceolate or linear, traversed by a single midrib, or by three parallel ribs; no veins.

Five species in the coal formation.

Genus 83. *Lepidostrobus*. Cones ovate or cylindrical, composed of imbricated scales, inserted by a narrow base, around a cylindrical woody axis, their points sometimes dilated and recurved in the form of rhomboidal disks; seed solitary, oblong, not winged, nearly as long as the scales.

Five species in the coal formation.

Genus 84. *Cardiocarpon*. Fruit compressed, lenticular, heart-shaped or kidney-shaped, terminated by a sharpish point.

Five species in coal formation.

MUSCI.

Genus 85. *Muscites*. Stem simple or branched, filiform with membranous leaves, having scarcely any midrib, and being sessile or amplexicaul, imbricated or somewhat spreading.

Two species in beds above the chalk.

CHARACEÆ.

Genus 86. *Chara*. (Gyrogonites, *Lamk.*) Fruit oval or spheroidal, consisting of five valves twisted spirally, a small opening at each extremity; stems friable, jointed, composed of straight tubes arranged in a cylinder.

Five species in beds above the chalk.

ALGÆ.

Genus 87. *Confervites*. Filaments simple or branched, divided by internal partitions.

Two species in the chalk marl.

Genus 88. *Fucoides*. Frond continuous, never articulated, usually not symmetrical or subcylindrical, simple or oftener branched, naked, or more commonly leafly, or membranous, entire, or more or less lobed, with no ribs, or imperfectly marked ones, which branch in an irregular manner, and never anastomose.

Four species in the transition rocks.
Seven in the bitumenous strata.
Three in the oolite.
Eleven in the chalk.
Eleven in the London clay.

PLANTS, THE AFFINITY OF WHICH IS ALTOGETHER UNCERTAIN.

Genus 89. *Sigillaria*. (Rhytidolepis, alveolaria, favularia, calenaria, &c., *Sternberg*.) Stem conical, deeply furrowed, not jointed, scars placed between the furrows in rows, not arranged in a distinctly spiral manner, smooth, much narrower than the intervals that separate them,

About forty species in the coal formation.

Genus 90. *Volkmannia*. Stem striated, articulated; leaves collected in approximated dense whorls.

Three species in coal.

These are possibly the leaves of calamites.

Genus 91. *Carpolithes*. Under this name are arranged all the fossil fruits to which no other place is assigned.

FOSSIL PLANTS FORMING COAL. There can be no doubt but that the valuable and important mineral, coal, has owed its origin to vegetable bodies. On examining a seam of coal, the upper layer of shale which forms the roof will be found to contain innumerable impressions of vegetable stems and leaves, most beautifully and faithfully preserved. Sometimes large portions of the trunks of trees are found traversing the centres of the coal seam; but in general, the central mass has been so compressed, and has undergone such a chemical change, as to obliterate almost all marks of its vegetable origin, and a mass of semi-crystallized bituminous matter alone remains. Yet, even in this bituminous mass, traces are occasionally to be found of organized structure. In thin slices of the three varieties of Newcastle coal, Mr Hutton thus describes the appearances of organization. "Each of these three kinds of coal, besides the fine distinct reticulation of the original vegetable texture, exhibits other cells, which are filled with a light wine-yellow coloured matter, apparently of a bituminous nature, and which is so volatile, as to be entirely expelled by heat before any change is effected in the other constituents of the coal. The number and appearance of these cells vary with each variety of coal. In caking coal, the cells are comparatively few, and are highly elongated. In the finest portions of this coal, where the crystalline structure, as indicated by the rhomboidal form of its fragments, is most developed, the cells are completely obliterated. The slate coal contains two kinds of cells, both of which are filled with yellow bituminous matter. One kind is that already noticed in caking coal, while the other kind constitute groups of smaller cells of an elongated circular figure. In those

varieties which go under the name of cannel, parrot, and splint coal, the crystalline structure, so conspicuous in fine caking coal, is wholly wanting. The first kind of cells are rarely seen, and the whole surface displays an almost uniform series of the second class of cells, filled with bituminous matter, and separated from each other by their fibrous divisions; and it seems probable, that these cells are derived from the reticular texture of the parent plant, rounded and confined by the enormous pressure to which the vegetable matter has been subject." In the more perfectly preserved specimens of fossil coal called jet, the ligneous structure is very apparent; so much so, as to indicate the kind of plant to which the coal owed its formation. The great extent and thickness of the coal fields in various parts of the world, show the vast quantities of vegetable matter which must have gone to the formation of them. Nearly one half of the surface of the west and north west part of England is composed of coal strata; and the coal fields of Newcastle cover an area of about 200 square miles. Besides these, there are extensive coal districts in Wales, in the southern part of Scotland, and in Ireland. Coal fields are also found on various parts of the continent of Europe, in North America, in New Holland, and within the arctic circles, as well as in the tropical parts of India.

These coal deposits are usually formed in hollow troughs, in successive layers varying in thickness from a few inches, to 10 and 20 feet, and alternating at various intervals with strata of sandstone and clay shale. The lowermost layer of the coal seam is generally composed of a hard clay ironstone, with a considerable admixture of earthy matters, while the upper layers or roof of the seam is formed of a clay strata rich in impressions of ferns and other coal plants. From the entire state of preservation in which these delicately formed plants are thus found, the conclusion has been drawn, that the greater number of the vegetable bodies have grown on the spot, or at least very near to where they are now found deposited; while on the other hand, the large rounded, branchless, and imperfect trunks of trees which are not unfrequently found irregularly interspersed among the coal strata, would as distinctly point out that many trees and vegetables had been drifted from other localities into the troughs which they now occupy.

Perhaps, if we suppose wide and extended tracts of level marshy ground, interspersed with lakes, through which large rivers flowed, in occasionally accelerated and flooded courses into the neighbouring ocean, we shall have a pretty good idea of the state of the country during the period when the carboniferous strata were formed. We must also suppose, that various changes of level had taken place during this period, by which the waters of the ocean sometimes encroached, and at other times retreated from the flat level shores; and that finally, by volcanic agencies, the whole had been broken up, and elevated into the positions which the coal fields at the present day present to our view.

The principal families of plants composing the coal strata, are ferns, calamites, lycopodiaceæ, sigillariæ, stigmariæ, and trees of the coniferæ and palm tribes. The same fossil plants, as already mentioned, are found throughout the whole known coal fields in every region of the globe; so that if we suppose these coal fields to be nearly of contemporaneous origin—and of this too there is strong proof, from their similar relative position with regard to other strata—we have strong reasons for supposing that a similar temperature, and a uniform distribution of the same vegetable products, existed at that period on the earth's surface. That this temperature was approaching to tropical, we have also reason to suppose, from the nature of the vegetables, most of which are allied to families which are now intertropical, or natives of climates with a higher temperature than that of Britain at the present day.

We shall now shortly describe some of the most remarkable plants of the coal series.

Lepidodendron, *(Sternbergii.)* This is one of the most common fossil plants of the coal fields.

230.

a Lepidodendron, Sternbergii. *b c* Lepidostrobus variabilis. *d* Lepidophyllum.

The figure represents only a portion or upper branch of the plant. The rhomboidal spaces with which the whole is regularly marked, were the base of the leaves, which appear to have been linear, lanceolate, and slightly incurved. The depression seen a little above the centre of the spaces, was the point where the leaves were attached; and the dark line which runs from this point downwards, was probably an original depression, unconnected with the union of the leaf. The general structure of the lepidodendron appears

to have been intermediate between the coniferæ and the lycopodiaceæ. They are very common both in the coal seams, and in the accompanying sandstones of the coal measures, and stems, from 20 to 45 feet in length, are frequently met with in the north of England. "In coniferæ," says Professor Lindley, "the leaves are arranged upon the stem in two very different ways: First, in the species having what botanists denominate fascicled foliage, such as the Scotch fir, the pinaster, and Weymouth pine; the first leaves that are developed, are brown and membranous, roll back, and wither away, almost immediately after the young branch has acquired its first growth. From the axilla of each of these sprouts forth a bud, which never or rarely elongates, but which produces several leaves, the outermost of which are membranous, and perishable like the first; but the innermost, narrow and rigid, forming the permanent green foliage of the species; in those where the foliage has fallen away, the stem is covered with numerous narrow projections, thickest at the upper end, where the remains of withered leaves are visible, arranged spirally with great symmetry, and separated by intervals usually equal at least to twice the breadth of the projections. Secondly, in the species in which the leaves are solitary, as in the spruce, fir, and araucaria, the leaves that are originally developed when the young shoot forms, never undergo any material alteration, but are those which subsequently become the green foliage of the plant; none, or few apparent axillary buds are developed; and finally, the leaves either separate by a clean scar of a rhomboidal or a roundish figure, with a depressed point in its middle, where the vascular bundle connecting the stem and leaf was broken through, or separate imperfectly, leaving behind an irregular mark upon a rhomboidal areola. The yew is an instance of the former, the araucaria of the latter. In all cases, the scars on the rhomboidal areolæ are disposed in a spiral manner, with the most exact symmetry. With coniferous plants of the latter kind, lycopodiaceæ accord so much in the arrangement of their leaves, and consequently in the appearance of the surface of the stems after the leaves have fallen, that it would be difficult to point out any difference, except that they are often, as in *lycopodium clavatum, rigidum, divaricatum*, a less spiral, having a tendency to become verticillate. Lepidodendron accord equally with coniferæ and lycopodiaceæ, in the arrangement of the scars of the leaves.

The foliage of certain coniferæ, such as araucaria and of lycopodiaceæ, is so similar, that their casts would be scarcely distinguishable, except by the larger size of the former. Lepidodendra accord better with coniferæ than with lycopodiaceæ in this respect. The ramifications of coniferæ and lycopodiaceæ are essentially different. In the former, the branches arise from the same place, on opposite sides of the main stem, often assuming a verticillate arrangement. In the latter, the branches bifurcate whenever a new bud is brought into action, so that the whole of the divisions are dichotomous, and the same takes place in the inflorescence whenever the latter is composed, as in *L. phlegmaria*. Hence, lepidodendra are more related to lycopodiaceæ than to coniferæ in their manner of branching; and as dichotomous ramifications are extremely rare in recent plants, this circumstance, taken together with their other characters, strengthens M. Brongniart's opinion of their strong analogy with lycopodiaceæ. The texture and size of lycopodiaceæ and coniferæ are very dissimilar. The former are soft cellular plants, with small, creeping, or erect stems, no bark, and an imperfect formation of a woody axis; the latter are large trees with a thick bark, and a hard woody centre, which is incapable of compression by any ordinary force. With neither tribe do lepidodendra agree in these points; they resemble lycopodiaceæ in their soft stem; for specimens some inches in diameter are found so compressed, as to be nothing more than a thin plate; but they agree with coniferæ in the size they seem to have attained, and in the presence of bark, although that part is thin compared with the bark of recent coniferæ.

There are several species of lepidodendron having distinct characters.

Lepidodendron selaginoides has circular scars, and short compactly imbricated leaves.

L. obovatum, with obovate areolæ, with a rounded apex, a tapering base, the central ridge even and undivided, and the scar at the apex of the areolæ bounded by a nearly circular outline. Large specimens are found on the continent and in Britain, in the coal seams, some 45 feet long, and 4½ feet in diameter.

L. elegans, scars similar to L. Sternbergii, but the leaves much smaller and more delicate, and the branches more slender and delicate.

231.

a Cardiocarpum acutum. *b* Lepidostrobus pinaster. *c* Lepidostrobus ornatus.

Cardiocarpum acutum. (Fig. *a*, cut 231,) found in groups in the shale from the Jarrow colliery, Newcastle. Each grain is lenticular,

acute at one end, and obtuse at the other; an elevated line runs through the axis, and there is in many an inner circle, with marks of a scar. Their seeds, which are small, probably grew in heads or clusters, and in pairs, not adherent to the calyx. They were probably seeds of a dicotyledonous plant, but of what kind it is impossible to form a conjecture.

Lepidostrobus. Oblong bodies (*b*, *c*, cut 230,) are of frequent occurrence along with the fragments of the lepidodendron and ulodendron. They are evidently seed vessels, somewhat similar to the cones of the coniferæ, and have been conjectured to be the cones of the lepidodendrons and ulodendrons. Although found plentifully associated with the stems of these fossils, no specimen has occurred where they were actually attached. Two or three species have been distinguished. *L. ornatus*, *l. variabilis*, and *l. comosus*. They consist of a conical axis, around which a quantity of scales are compactly imbricated, and pointing from the base upwards, (cut 230, fig. *c*.) Sometimes, however, in specimens, (cut 231, fig. *c*,) they are apparently turned downwards, which is perhaps owing to their having been forcibly compressed from above downwards. The specimens vary much according to their age.

Lepidophyllum. (Fig. *d*, cut 230.) These lanceolate figures appear to be the leaflets of the lepidodendron.

232.

Ulodendron.

Ulodendron. The plants to which the fossil fragments so frequently found in the coal strata must have belonged, and to which the name of ulodendron has been given, must have borne a near resemblance to the lepidodendron; indeed, by some, the former are supposed to be only older specimens of the latter, with their areolæ altered by age and the lateral expansion of the bark. There are grounds for supposing, however, that the ulodendrons are distinct plants, and that they may have formed a family allied to the lepidodendrons. The general markings of the bark will be seen from the figure to be somewhat different in shape from the areolæ of the lepidodendron; and interspersed over the surface of the bark at irregular intervals are larger scars, which may have been the points of attachment of branches or masses of inflorescence. "They are," says Mr Lindley, "connected with these scars, two considerations of much importance. 1st. That the supposed masses of inflorescence were not only neither terminal, nor disposed spirally upon the stem, but were also produced upon the old trunks, and not upon the young branches, circumstances at variance with any thing we know of recent coniferæ or lycopodiaceæ; and, 2dly. That the scars are placed one beneath the other, and not spirally, or alternately upon the stem. The stems were most likely cylindrical, though the fossils have been rendered flat by pressure. Two species have been enumerated. *u. majus*, and *u. minus*, but the latter may only be a younger specimen of the former.

Bothrodendron Punctatum, *Lindley*. Two specimens were found in the Newcastle coal seam. "Upon the surface of the stem are discoverable a considerable number of minute dots, arranged in a quincuncial manner, something less than half an inch apart, and it is probable that these may be the scars of leaves, at intervals of ten or twelve inches; the stem is marked with deep circular concavities four or five inches across, at the bottom of each of which is a distinct fracture, indicating that something has been broken out, while the sides of the concavities have concentric marks, as if from the pressure upon the rounded scales. Fragments were found in these cavities, which show that they are the points of attachment of very large cones, consisting, as far as can be made out from what is left of rounded polished scales, three-tenths of an inch thick, attached to a central axis, and fitting accurately to each other. Upon the whole, they have so completely the appearance of the base of such a strobilus as that of Pinus Lambertiana, that we cannot doubt that the plant belonged to the natural order coniferæ. In recent plants, however, we have nothing at all like this in the manner in which the cones appear, for it seems as if they grew from the old trunk, unless, indeed, we are to suppose, of which there is no proof, that the plant knew no seasons, but grew with such rapidity that its branches had acquired by the second year a diameter of seven or eight inches."*

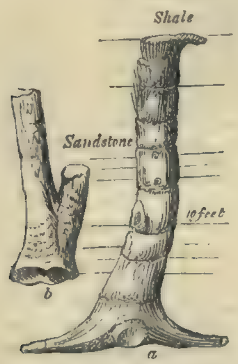
Sigillaria. This is a genus of which there are several species, very commonly found in the coal fields. The stem is conical, deeply marked at intervals with furrows, but not jointed. Nu-

* Fossil Flora, Vol. II.

merous scars are situated between the furrows, arranged in rows. The specimens are generally found in two states: 1st. With the bark entire, in which case the scars are clean, broad, and well defined; 2d. Where the bark has been destroyed, and nothing is seen but the passage through which the vessels of the leaf communicated with the stem. In these latter, the scars are narrow, small, indistinct, and often double.

Large portions of these stems are frequently found lying across the strata, having escaped compression, with roots proceeding from them on all sides. They are generally surrounded by a coating of coal about an inch in thickness. The longitudinal flutings with the scars are often awanting, or very indistinct, on the lower or root portions of the larger stems. The stem has been originally hollow, and in the fossil state is filled with sandstone, very generally of a different kind from that of the enveloping strata, a proof that these plants have been drifted from

233.



a Sigillaria pachyderma. *b* Branched fragment of root.

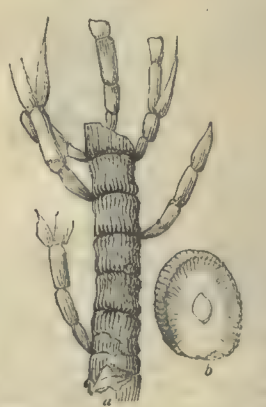
a different locality. The wood cut represents one of these fossils found immediately above the coal in Killingworth colliery, near Newcastle.* The lower part was two feet in diameter, coated with coal, and indistinctly fluted; the roots were imbedded in shale, and could be traced four feet or more from the stem, branching, and gradually growing less. Fig. *b* represents one of the larger roots. These roots, as well as the whole of the stem, were composed of fine grained white sandstone, totally different from the rock in which the lower portion of the fossil was enveloped, but agreeing perfectly with a bed surrounding the higher part. At the height of about ten feet, the stem was partially broken and bent over, so as to become horizontal; and here it was considerably distended laterally, and not more than an inch thick, having the flutings comparatively distinct. This stem formed one of a considerable group, not less than thirty being visible within an area of fifty yards square, some of them larger than this individual, all presenting the same general characters; and the perpendicular trunks of this fossil are often the cause of serious accidents to the colliers, as the coally envelope weakens the cohesion of the strata, causes them to detach themselves, and suddenly slip out of the roof after the seam of coal has been removed from below, when they leave large circular holes, sometimes four to five feet in diameter. M. Brongniart describes a stem which he traced in the strata of the coal mines of Kunzwerk, near Essen, as extending along the line of the strata for forty feet, its diameter gradually decreasing towards the top, when it branched out into two, each branch being about four inches in diameter. Some have associated the sigillariæ with the tree ferns, others with the cacteæ. From the sigillaria having a true and distinct bark, they are in all probability dicotyledonous.

* Lindley and Hutton's Fossil Flora, Vol. I.

There are several species; *sigillaria pachyderma*. *S. alternans*, with a double row of approximated oval scars, each with a smaller scar in the centre. *S. reniformis*, with roundish kidney-shaped or double approximated scars, with a point in the centre. *S. catenulata*, with oval scars, united at the ends, forming a sort of chain. *S. oculata*, with large oval scars, and an eye in the centre.

Calamites. These, which are also abundant in the coal strata, appear to have been branching plants, with hollow stems, and a distinctly separated wood and bark, often many feet in length, and readily separating at their joints. The whole substance appears to have been very soft and reed-like, so as to be easily compressed, the internal cavities at the joints most probably supported by horizontal partitions. The surface of the stems was marked with numerous parallel furrows, converging in pairs towards the joints,

234



a Calamites mugeotii. *b* Partition of a joint.

and then turning abruptly inwards. They were branching plants, as the figure above shows.

These branches proceed from the joint, gradually thicken towards the middle, and taper again towards the extremities, the one of these branches divides into two at the top. In this specimen, which was found in the Edinburgh carboniferous sandstone, by H. Witham, Esq., there is no trace of leaves. It appears identical with the *c. mungeotii*, found by Brongniart in the new red sandstone of the Vosges. Fig. *b*, is one of the internal partitions of the joints, and such are frequently found in iron nodules. The stems of calamites were hollow, and readily yielded to pressure, without being much altered. They often contain in the interior fragments of ferns and other plants. They probably had a distinct wood and bark; at least, such is the opinion of Brongniart. From this circumstance, they may belong to the dicotyledonous plants, although they have been compared to the equisetaceæ. Young branches have been discovered, not, however, attached to the trunks, with small whorled leaves. There are several species not by any means distinctly identified.

Asterophyllites. Only fragments have hitherto been obtained of this genus, which consist of cylindrical stems, with short joints, about near as broad as they are long, with small verticillate leaves. They bear a close resemblance to the calamites, only the longitudinal furrows are not present on the stem. They were probably dicotyledons. They are found occasionally in the coal strata.

Stigmaria Ficoides. This is, perhaps, the most common and abundant plant composing the coal seams, and has been early taken notice of, and described by many writers on the subject. It appears, also, to differ so much from all known vegetable productions of the present era, as to merit the distinction of an entirely new class of plants. From the numerous quantities of this plant, which are found scattered among the coal, shale, and accompanying sandstones of the carboniferous series, there can be no doubt that it was one of those vegetables which have mainly contributed to the formation of coal, and on this account also, its structure and supposed habits merit particular attention. The usual form in which the fragments of this fossil are met with, is that of a cylinder, more or less compressed, and generally flatter on one side than the other; not unfrequently the flattened side turns in, so as to form a groove. The surface is marked in quincuncial order, with spots, or rather depressed circles or areolæ, with a rising in the middle, in the centre of which rising a minute speck is often observable. From different modes and degrees of compression, and probably from different states of the original vegetable, these areolæ assume very different appearances; sometimes running into indistinct rimæ, like the bark of an aged willow; sometimes as in the shale, impressions exhibiting little more than a neat sketch of the concentric circles. It is supposed that these circles are the marks of the attachment of the peduncles of leaves; these leaves or spines also appear to have been cylindrical, and often of considerable length. Woodward long ago remarked, that along the flattened or grooved side of the cylinder, there frequently ran an included cylinder, which at one extremity of the specimen would approach the outside, so as almost to leave the trunk, while at the other it seemed nearly central. These internal cylinders were frequently flattened from pressure. Occasionally the specimens are found forked or branched, and in one or two instances, a terminal portion has been discovered when the point was obtuse, "closing from a thickness of three inches, to an obtuse point."

We have said that fragments only of the plant are generally found, but several more entire and perfect specimens have been discovered in the Newcastle coal seams, by which the original structure can be more accurately determined. From these, it appears that the stigmaria, instead of growing upwards and spreading out its arms from a vertical trunk, was a prostrate plant, and sent out its succulent cylindrical branches, which were sometimes forked, from a central convex cup or trunk.

235.

Stigmaria Ficoides.

The wood cut, which is an attempted restoration of the original form of the plant, from the various fragmentary views given of it, will point out the mode of its growth.

In one specimen obtained from the Jarrow colliery, Newcastle, the central trunk measures three feet in diameter; fifteen arms, four of which are distinctly branched, were counted on another specimen, the lengths of the fragments of which varied from four feet downwards. Steinham calculates that these arms may have exceeded twenty feet in length. To show the multitude of these fossil plants, no less than fourteen stems were discovered in Jarrow colliery, within a space of 600 yards square. Huge masses of shalely sandstone, dug out of the upper beds of the Craigleith quarries, near Edinburgh, have also exhibited innumerable fragments of the stigmaria; and one block of several tons' weight examined by us, appeared to contain a large plant with its long arms and massy central cup several feet in diameter. From a fragment of stigmaria

preserved in the ironstone of Colebrookdale, the following structure was apparent on sliced sections being made. The transverse section exhibited a meshing, something like that of the coniferæ, but with no concentric circles, and with the medullary rays consisting rather of open spaces between the other tissue, than of the common muriform tissue found in such places. The longitudinal sections presented an assemblage of spiral vessels of a very tortuous and unequal figure, without any woody or cellular matter intermixed. These formed a cylinder, which was surrounded externally by a mass of organic mineral matter, upon whose surface the peculiar markings of stigmaria were preserved, and which enclosed a hollow cavity, altogether destitute of mineral deposit. It would, therefore, appear, that the stigmaria was a plant with a very thick cellular coating or bark surrounding a hollow cylinder, composed exclusively of spiral vessels, and containing a rather thick pith; and that the plates of cellular tissue which preserved the communication between the bark and the pith, were of so delicate an organization, that they disappeared under the mineralizing process which fixed the organic character of the woods. On the whole, then, it appears that this curious and unique specimen of ancient vegetation was a prostrate horizontally spreading plant, with succulent cylindrical branches, and, perhaps, leaves, and that it belonged to the dicotyledonous division, and, perhaps, was allied to the *cacteæ* or *euphorbiaceæ*. The stapelias of the Cape of Good Hope, and the carallumas of India, have a branching habit similar to that of stigmaria, but otherwise their structure is different. Of rapid growth, and frequenting probably a level, flat, and muddy soil, with an elevated temperature, and abundance of moisture, this plant appears admirably adapted for forming those accumulations of carbonaceous matter, of which we find the coal beds exclusively composed. From the state of preservation in which the originally soft and succulent portions of this plant are found, it appears pretty evident that it must have grown in the situations, or very nearly adjoining to where it now exists; or at all events, could not have been far transported with any great agitation or violence. M. Steinhaur thus endeavours to explain the probable manner in which these fossils have been preserved. "Annual decay, or an accumulation of incumbent mud, having deprived the trunks of the vegetating principle, the clay would be condensed by superior pressure around the dead plant, so as to form a species of matrix. If this took place so rapidly, that the mould had obtained a considerable degree of consistency before the texture of the vegetable was destroyed by putrefaction, the reliquium was cylindrical; if, on the contrary, the new formed stratum continued to subside, while the decomposition was going on, it became flattened, and the inferior part might even be raised up towards the yielding substance in the inside, so as to produce the groove or crest on the under side, in the same manner as the floor in coal works is apt to rise when the measures are soft, and the roof and sides have been secured. While the principal mass of the plant was reduced to a soft state and gradually carried away or assimilated with mineral infiltrated matter, the central pith being unsupported, would sink towards the under side, and this the more sensibly, when its texture was most distinct, while its anterior extremity would probably go into putrefaction with, and be lost in, the more tender part of the plant. The mineral matter introduced would now form an envelope round the pith where this resisted decomposition for a sufficient length of time; and when it was ultimately removed, if the surrounding mass was still sufficiently pervious, be also filled with argillaceous matter; or if it was too much indurated, be left empty, which is the case occasionally. The epidermis or external integument of the vegetable appears to have resisted decomposition the longest, as in many cases it has been preserved from putrefaction in the manner necessary to change it into coal; its place more frequently, however, is occupied by a ferrugineous micaceous film. It therefore appears that the original plants must have undergone a destruction by putrefaction, and the vacuities thus occasioned been very rapidly filled up with mineral matter. From this, several interesting conclusions may be drawn. The formation of these strata from the deposit of water is clearly ascertained; also, that the argillaceous strata in question must have been, when originally deposited, of nearly the same thickness as they now are, as appears from the undisturbed position of the vegetables, of which they were once the bed and are now the tomb. On the other hand, the strata of coal or slate clay, appear to have originated from a great number of successive depositions, which must have been of a very diluted consistence when vegetation became extinct in the plants, of which they now bear the impressions. All these strata must be supposed to have been successively at no great depth from the surface of the water resting upon them, that these plants might be supplied with air; and the situation in which they are found precludes the possibility of any motion of that sea sufficiently violent to disturb the bottom. The general diffusion of this, and several of the following species, strongly suggests the belief, that all the coal strata through which they are dispersed owe their existence to a similar origin."

Favularia Tesselata. This fossil was found in a bed of sandstone overlying the coal strata at Garthen colliery, Denbighshire. One or two other specimens have been found in other loca-

lities, but the plant is comparatively rare. This fossil is a mould of fine grained sandstone, and

236.

Favularia Tesselata.

was about three feet long. It retains, on one side, some of the carbonized vegetable substance which also fills the cavities of many of the scars; it is clearly and beautifully detached from the enveloping sandstone on three sides, and somewhat flattened, so that a transverse section would be an oval. The rows of scars run longitudinally or parallel with the axis of the stem, with perfect regularity, each row being separated by a groove; the rows are narrower and more strongly marked on the side, which, from its shape, would appear to have been subjected to the least pressure. The scars in the middle of the area are somewhat club-shaped, the central lobe much elongated, and very various in width, and not so deeply sunk as the shorter lateral ones. There is no indication of a central woody axis; and it appears to have been the stem of some plant, the leaves of which were placed so close together, that their bases, which were square, were in contact. It was probably dicotyledonous, and perhaps allied to sigillaria.

Ferns. There are numerous species of ferns found in the carboniferous strata, most commonly in the shale forming the roofs of the coal seams; but also frequently in the sandstone and fresh water limestone underlying the sandstone. These ferns are often beautifully preserved, yet as in the recent species, it is often difficult to arrange and classify them. Like the other vegetable fossils of the lower strata, they differ considerably from recent genera and species, to which they are naturally allied.

In the known numbers of existing plants, ferns bear a very considerable proportion. Thus we have about 1500 known ferns, and 45,000 phanerogamic plants, being in the proportion of 1 to 30. In Europe, this proportion varies from 1·35, to 1·80. In the tropics, the numbers are 1·36, and 1·20. The circumstances most favourable to the growth of these plants are humidity, heat, and shade, and thus they find favourable habitats in small wooded tropical islands, where the surrounding ocean affords a constant supply of moisture.

In the coal strata, ferns greatly predominate over all other vegetables. The present ascertained number is about 120 species, forming nearly a half of the fossil flora. These species for the most part belong to the tribe of polypodiaceæ. In the table already given, we have inserted the genera, and the following figures will give a sufficient idea of a few of the species.

237.

Neuropteris loshii. Neuropteris gigantea. Neuropteris accuminata.

Sphenopteris affinis. Pecopteris heterophyllum. Sphenopteris dilatata.

In general, these ferns are most beautifully preserved in the shale, and especially in some kinds of fresh water limestone, as that of Burdiehouse, near Edinburgh. In the bituminous shale at Wardie, near Edinburgh, some specimens of the *sphenoteris affinis* are so perfectly preserved, as to admit of portions of the plant being taken up entire, and pasted on paper like a recent fern. Several fragments of the larger stems of arborescent ferns are occasionally met with in the coal strata.

Lycopodites Williamsonis, (see cut 238, fig. *a.*) This fossil plant is very common in the oolite of Scarborough. It appears to have been a creeping plant, like the recent *lycopodium clavatum*. The stem is frequently branched, and concealed by the base of the leaves, which are sessile, and of an acute filiform shape; one or two strongly marked ridges run up the centre of each leaf, which appear to be the edges of angles. The leaves are opposite, with frequently smaller ones intermediate. The surface of the stem is covered with scales, apparently the base of leaves which have lost their points. The stems are terminated by a large oval head or cone, which is covered with small hook-like processes, similar in form to the leaflets, but smaller. When the bituminous

substance is destroyed, there are strongly marked rhomboidal spaces looking like scars. These heads are rare, though the fragments of the plant are in abundance. The fossils are much larger in size than any recent allied species. In the specimen figured in the cut, the cone is upon the main stem, but cones are also found in the lateral branches. These cones very much resemble those described under the name of lepidostrobus, and the plants may have been similar.

CONIFERÆ. A considerable number of fossil species of coniferæ have been discovered, both in the secondary and tertiary strata. It is only within the last few years, however, that species of the true coniferæ, analogous to existing pines and araucarias, have been identified in the coal measures. Large trunks of trees have been found in the sandstone strata, near Edinburgh, as well as in the Newcastle coal fields, which, from the pecularity of their internal structure, leave no doubt of their having been of the pine tribe. The peculiar structure of the coniferæ, has already been alluded to and illustrated by the figure in Plate I. By these it will be seen that the transverse sections of such woods, in addition to the usual medullary rays and concentric lines of annual growth, exhibit under the microscope a system of reticulations, by which they are distinguishable from all other plants. In longitudinal sections again, a system of vessels called discs, with central areolæ, are also visible, and these vary in the different genera, so as to afford data for the discrimination of the araucarias from the other coniferæ. This discovery is due to the ingenuity and perseverance of William Nicol, Esq. of Edinburgh.* In some coniferæ, the discs are in single, and in others in double and triple rows. Throughout the whole family of existing pines, where double rows of discs occur, the discs of both rows are placed side by side, and never alternate, and the number of rows of discs is never more than two. In the araucarias, the groups of discs are arranged in single, double, triple, and sometimes quadruple rows. They are generally smaller than those in the true pines, about half their size, and in the double rows, they always alternate with each other, and are sometimes circular, but mostly polygonal. Mr Nicol has counted a row of not less than fifty discs in a length of the twentieth part of an inch, the diameter of each disc not exceeding the thousandth part of an inch; but even the smallest of these are of great size, when compared with the fibres of the partitions bounding the vessels in which they occur. A fossil trunk of an araucaria was found in Craigleith quarry, near Edinburgh, in 1830. Another mass twenty-four feet long, and three feet in diameter, was partially exposed in the same quarries, in 1833, and a third in the Wardie quarries in 1839. The longitudinal sections of these trees exhibit a structure exactly similar to the sections of the recent araucaria excellsa, that is, there are small polygonal discs arranged in double, triple, and quadruple rows, with the longitudinal vessels.

* Edin. Phil. Journal.

Specimens of the coniferæ are not uncommon in the lias and oolite formations; and Brongniart has enumerated twenty species in the tertiary strata. Branches of the araucaria, with the leaves still adhering to them, have been found in the lias of Lyme Regis.

A portion of the *araucaria peregrina* was found in the lias of Lyme, Dorsetshire. It is a very perfect specimen of a branch with the imbricated leaves, which are larger and blunter than the *a. excelsa* of Norfolk island, but in other respects remarkably similar. Mr Nicol remarks, that in fossil woods from the Whitby lias, where concentric layers are distinctly marked on their transverse section, the longitudinal sections have also the structure of pines; but when the transverse section exhibits no distinct annual layers, or has them but slightly indicated, the longitudinal section has the characters of araucarias. So also those coniferæ of the coal formation of Edinburgh and Newcastle, which exhibit the structure of araucaria in their longitudinal section have no distinct concentric layers, whilst in the fossil coniferæ from the New Holland and Nova Scotia coal field, both longitudinal and transverse sections agree with those of the recent tribe of pines.

238

a Lycopodites williamsonis. *b* Pinus primœva.
c Trigonocarpum noggerathii. *d* Pinus canariensis.
ee Carpolithes conica. *f* Zamia ovata.
g Lepidodendron oocephala. *hh* Carpolithes.

Fig. *d* is a cone of *pinus canariensis*, found in tertiary strata in Spain, and apparently analogous to pines at present growing in the Canary islands.

PALMS. Evident traces of the branches of palm trees have been found in the coal formations, and some fossil fruits, which bear a strong resemblance to the cocoa-nut and date, though of a diminutive size, have been obtained in good preservation from the Newcastle coal fields. (Fig. *c* cut 238,) represents one of these fruits in

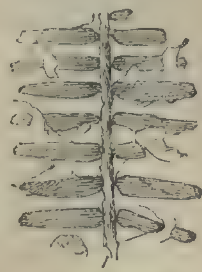
our possession. Several similar are also figured in Lindley and Hutton's work from the same locality, and are there designated *trigonocarpum noggerathii*. Palm leaves and stems are found in great abundance, and in good preservation, in the upper, secondary, and tertiary beds; and in the island of Sheppey, immense numbers of palm fruits and others of tropical climates are found associated with marine shells and fragments of various woods. Fig. *b* is a cone bearing a close analogy to that of the Scotch fir, only smaller, and found in the oolite. Figs. *e e* and *h h*, are also fruits resembling those of the palm tribe.

Cycadeæ. There are only two existing genera of this family, cycas and zamia, natives of South America, India, China, and New Holland, whereas five fossil genera have been discovered, containing about thirty species. These occur chiefly in the secondary strata of the lias, oolite, and chalk, and occasionally, though more rarely, in the tertiary series. These plants seem to have been the chief materials whence the partial beds of lignite or brown coal have been formed. Of this description is the coal of Cleveland Moorland, near Whitby; of Brora in Sutherlandshire; of Buckeberg, near Minden, in Westphalia. The Bovey coal and lignite of Œningen are found in the tertiary strata. The amber which is found on the eastern shores of England, and on the coasts of Prussia and Sicily, is supposed to be a resinous exudation from the beds of lignite, found in the tertiary strata. Fragments of fossil gum were found near London, in digging the tunnel through the London clay at Highgate.

The cycadeæ form a beautiful family of plants, and from their structure, assimilate in many respects with palms, coniferæ, and ferns. The trunk of the cycadeæ has no true bark, but is surrounded by a dense case, composed of persistent scales, which have formed the bases of fallen leaves; these, together with other abortive scales, constitute a compact covering that supplants the place of bark. The leaves rise around a single cone like the pine apple, and are pinnatifid; the fossil species appear to agree with the recent in the following particulars of structure: 1. By the internal structure of the trunk, containing a radiating circle or circles of woody fibre, embedded in cellular tissue. 2. By the structure of their outer case, composed of persistent bases of petioles in place of a bark, and by all the minute details in the internal organization of each petiole. 3. By their mode of increase, by buds protruding from germs in the axillæ of the petioles.

A number of silicified fossil trunks of cycadeæ are found in the isle of Portland, immediately above the surface of the Portland stone, and below the Purbeck stone. They are lodged in the same beds of black mould in which they grew, and are accompanied by prostrate trunks of large coniferous trees converted into flint, and by stumps of these trees standing erect with their roots still fixed in their native soil.*

239



Frond of pterophyllum.

This cut represents a portion of a frond, either of a zamia or pterophyllum, found in the lias beds at Cromarty, in the north of Scotland. The structure of the leaflets, which are of the same breadth throughout, would indicate its belonging to the species pterophyllum. (See p. 653).

Fig. *f*, cut 238, represents a cone of the zamia, as figured by Lindley and Hutton, from the greensand formations of England.

In a tertiary fresh water formation at Œningen, Professor Braun has enumerated thirty-six species, chiefly dicotyledons, about two-thirds of which belong to genera which still grow in that neighbourhood, but their species differ and correspond more nearly with those now existing in North America, than with any other European species. On the other hand, there are some genera which do not exist in the present flora of Germany, and others not in Europe. Judging from the proportions in which their remains occur, poplars, willows, and maples, were the predominating trees in the former flora of Œningen. Of two very abundant fossil species, one, the populus latior, resembles the modern Canadian poplar; the other the populus ovalis, resembles the balsam popular of North America. The determination of the species of fossil willows is more difficult. One of these, the salix angustifolia, may have resembled our present salix viminalis.

Of the genus acer, one species may be compared with acer campestre, another with acer pseudoplatanus; but the most frequent species, acer protensum, appears to correspond most nearly with the acer dasycarpon of North America. To another species, related to acer negundo, Mr Braun gives the name of acer trifoliatum. A fossil species, liquidambar europeum, differs from the existing l. styraciflum of America, in having the narrower lobes of its leaf terminated by

* Buckland Geol. Transact.

longer points, and was the former representative of this genus in Europe. The fruit of this liquidambar is preserved, and also that of two species of acer, and one salix.

The fossil linden tree of Œningen, resembled the modern large-leaved linden, t. grandiflora. The fossil elm resembled a small-leaved form of ulmus campestris.

Of two species of juglans, one may be compared with the American j. nigra, the other with j. alba, and like it, probably belonged to the division of nuts with bursting external shells. Among the scarcer plants, is a species of diospyros; a remarkable calyx of this plant is preserved, and shows in its centre the place where the fruit separated itself; it is distinguished from the living diospyros lotus of the south of Europe, by blunter and shorter sections. Among the fossil shrubs are two species of rhamnus, one of which resembles the r. alpinus, in the costation of its leaf. The second and most frequent species, r. terminalis, may, with regard to the position and costation of its leaves, be compared in some degree with r. catharticus, but differs from all living species, in having the flowers placed at the tips of the plant.

Among the fossil leguminous plants, is a leaf more like that of a fruticose cytisus than of any herbaceous trefoil.

Of a gleditchia, there are fossil pinnated leaves and many pods; the latter seem, like the g. monasperma of North America, to have been single-seeded, and are small and short, with a long stalk contracting the base of the pod.

With these numerous species of foliaceous woods, are found also a few species of coniferæ. One species of abies is still undetermined; branches and small cones of another tree of this family resemble the cypress of Japan.

Among the remains of aquatic plants are a narrow-leaved potamogeton, and an isoetes, similar to the i. lacustris now found in small lakes of the black forest, but not in the lakes of Constance.

The existence of grasses at the period when this formation was deposited, is shown by a well preserved impression of a leaf similar to that of a triticum, turning to the right, and on which the costation is plainly expressed. Fragments of fossil ferns occur here, having a resemblance to pteris aquilina and aspidium filix mas. The remains of an equisetum, indicate a species resembling e. palustre. Among the few undetermined remains, are the five-cleft, and beautiful veined impressions of the calyx of a blossom, which are by no means rare at Œningen. No remains of any rosaceæ have yet been discovered.*

* Buckland's Geology, p. 514.

CHAP. LVII.

PRACTICAL CULTURE OF PLANTS.

As soon as nations begin to emerge from the rudest states of society, in which condition they have lived by the chase, and the precarious supply of the natural productions of the earth, they turn their attention to the cultivation of vegetable substances in fields and gardens. We accordingly find, that the artificial culture of the cerealia has been of such early invention, that not only all historical traces of its origin are lost in remote antiquity, but even the specific kinds of grains thus changed by cultivation, or the countries where they were really indigenous are at the present day impenetrable mysteries. To agriculture, horticulture in due time succeeded. In warm climates, where fruits are produced in a perfect state by the liberal hand of nature, gardening, as a means of subsistence, was of minor importance; whereas, in colder regions, the transportation of useful fruits and vegetables, and their careful culture by artificial means, have afforded incalculable advantages to mankind.

We very early begin to read of gardens constructed both for pleasure and utility. The hanging gardens of Babylon have been represented as romantic in point of situation, and magnificent not only for their extent, but also for the natural difficulties which were surmounted in their construction. The useful had, however, but little part in their design; and of the less aspiring spots, which were made to minister to the wants of the people of that city by the production of esculent vegetables, it has not been thought necessary to say one word.

We have abundant reason for believing that the Jews, during their existence as an independent nation, were accustomed to cultivate fruits in abundance, but no mention can be found of the particular herbs and plants which they without doubt produced for their daily consumption.

Our knowledge of the mode of gardening practised in the Chinese empire has been obtained at periods of recent date; yet, from what we know of the inveterate pertinacity wherewith its inhabitants adhere to the customs of their ancestors, we are warranted in believing that the practice of this art has been without any material alteration for many centuries. The learned Jesuits Du Halde and Le Comte, who resided as missionaries in China, speak in commendation of the manner in which the cultivation of culinary vegetables is managed in that country, where, indeed, the practice of horticulture appears to have reached to considerable perfection, although the scientific principles upon which it should be founded are wholly unknown.

It is said that the lower orders of people in some parts of China, draw a chief part of their nourishment from the produce of their gardens, and that they are in possession of some garden esculents which are peculiar to themselves. We are indebted to China for several valuable additions to our flower-gardens, and among the rest for various species of the Camellia, Pœonia, and Rose; and it is reasonable to suppose that the same care would have been taken for the transmission of seeds of new descriptions of esculents had any such presented themselves.

In an empire comprehending so great a variety of climate, the natural productions must doubtless be extremely varied, and the Chinese are said to be in the enjoyment of most of the fruits and vegetables that are reared throughout Europe. There is little that is worthy of remark in what has been stated with regard to the methods employed for the cultivation of their vegetable gardens. Recent travellers have endeavoured to throw an air of discredit upon the relations of the learned men whose accounts have been already noticed. It is indeed, not impossible that these reverend fathers may have endeavoured to draw a little upon the credulity of their readers; but, on the other hand, it must be considered, that while our own intelligent countrymen who have been admitted within the borders of the celestial empire have had their opportunities for observation limited to the time employed in the performance of a rapid journey, during which they were always watched by a government escort, their precursors remained for a considerable time in the country, and could consequently examine things at their leisure and in comparative freedom.

From the earliest times the Persians have been great gardeners; but historians and travellers have only thought deserving of their notice gardens which have been constructed for the pleasure of monarchs, or as proofs of their wealth and power.

That the Greeks also took pleasure in horticultural pursuits we have the direct testimony of Theophrastus and Aristophanes. Flowers were always in great request among them. At convivial meetings, at public festivals, and in religious ceremonies, the presence of these was always required. To so great an extent was this use of flowers carried, that artists were established in Athens, whose sole occupation it was to compose wreaths and crowns with flowers of different species, each of which was understood to convey some particular mythological idea.

The Romans, amid all their conquests, never forgot to forward the useful arts of life, but carried with them into other countries such as they already possessed, while they showed themselves to be willing learners of others which they found established and which were new to themselves. It is fortunate for the interests of humanity that the benefits which they thus became the means of disseminating, were in their nature such as would soften and repair the miseries occasioned by the sword; and that these benefits have remained to bless the countries which their armies overran.

It may be supposed, that an art which was capable of ministering so greatly to their personal gratification as that of vegetable gardening, would not be neglected by the Romans. Columella has given a very considerable list of culinary plants which they possessed, and some of these must have been both excellent and plentiful, since he speaks of them as being esteemed both by slaves and kings.

The more luxurious among the Romans were accustomed to force vegetables, and the emperor Tiberius is said to have been so fond of cucumbers, that he secured by that means a supply for his table throughout the year.

The kitchen-gardens of the modern Italians contain nearly every vegetable that we possess; but their methods of cultivation are not such as to afford them in that degree of perfection in which we are accustomed to enjoy them, and to which the climate would seem qualified to bring them. The gardens of the peasants throughout the Italian states are but scantily supplied, gourds and Indian corn comprising nearly all which they are made to contain. It is only in the gardens attached to religious houses that horticulture is pursued with any skill. In the labours of these the friars themselves are accustomed to assist, while in other situations in that country the office of a gardener is commonly filled by one who has had little or no instruction to fit him for the employment.

Gardens are found universally throughout the Netherlands, so that, to use the words of Sir W. Temple, "gardening has been the common favourite of public and private men;—a pleasure of the greatest, and a care of the meanest, and indeed an employment and a possession for which no man there is too high nor too low." There is not a cottage to be seen which has not a garden attached to it; and although this is sometimes exceedingly small, the high degree of culture which is bestowed upon it renders the spot available for the comfort of the cottager's family. Towards this desirable object every particle of matter capable of ameliorating the soil is carefully collected and applied. From these circumstances, it may be readily supposed that the Dutch are possessed of every fruit and esculent vegetable that their climate is capable of maturing.

In France, although gardens are not nearly so universal as in Holland, they are still very generally met with, their characteristic quality being that of neatness. This statement refers, however,

more correctly to the northern than to the southern division of the kingdom, where the cottagers' gardens resemble much those of the Italian peasants, as well in their careless mode of culture as in the paucity of their contents. Nothing can be objected against the system pursued by the market gardeners who supply the French metropolis, and by whose skill and industry many vegetables are brought to a very luxuriant growth.

In the north of Europe gardening is in general a favourite pursuit, and the cottages of the peasants are for the most part provided with a spot of ground sufficient in extent to answer the demands of their inmates. This is not so much the case, however, in the Prussian dominions. Cabbages and potatoes form the greater part of the produce there obtained by the cottagers. The gardens of the higher classes are very differently managed, so as to produce vegetables in great variety and abundance.

The art of gardening in Russia, in common with many other useful pursuits, owes its origin to Peter the Great. Previous to the reign of this monarch, there was scarcely such a thing known throughout the empire as a garden, and the only culinary vegetables grown in the country were a few species of stunted kale. Even now the use of gardens in that country is confined to the great and wealthy of the land, and their choice of culinary vegetables is but small. A considerable improvement in this respect is, however, visible of late years, during which time many additions have been made to their kitchen-gardens by different travellers.

Potatoes are now cultivated to some extent in Russia, but they are of recent introduction, and it was for some time difficult to induce the peasantry either to cultivate or to eat them, for the simple reason that they came recommended by their lords, who were not unnaturally perhaps suspected of some selfish or sinister motive in that recommendation. Horticulture has attained to a high degree of perfection in Russia under the auspices of its princes and nobles, and it is a curious fact that more pine-apples are grown in the immediate vicinity of St Petersburgh, than in all the other countries of continental Europe.

In Poland, gardening was practised earlier than in Russia, considerable progress having been made in the art at the end of the seventeenth century, during the reign of Stanislaus Augustus. There is a very remarkable garden at Warsaw, known by the name of Lazenki. This was formed, and the palace to which it was attached was built, by the last king of Poland. Among other curious and some very magnificent objects in these gardens, are numerous pedestals ranged in various situations, and upon these, instead of sculptured statues, living human figures of both sexes were placed on festal occasions. These persons were dressed in classical costume, and were taught to assume and maintain certain attitudes in keeping with the characters they were intended to represent.

It is to Spain that the rest of Europe is indebted for the introduction of many plants from Mexico, Chili, and Peru. Seeds were brought from these regions, in the reign of Ferdinand the Sixth, for the royal garden of Madrid, whence their produce has been distributed. Spain is very rich in cultivated fruits, so that some species are made to form articles of external commerce; but the same pre-eminence in garden cultivation does not now appear which was claimed for her by Columella in the time of the Roman republic, and which was probably as well deserved during the dominion of the Moors. The oldest and most extensive gardens now to be found in Spain are of Moorish origin, and have once been appendages to the palaces of their Arabian kings.

The Chinampas, or floating gardens of Mexico, are justly considered objects of the greatest curiosity. The invention of these gardens is said to have arisen out of the extraordinary situation in which the Aztecs were placed on the conquest of their country by the Tepanecan nation, when they were confined in great numbers to the small islands on the lake, and were driven to exercise all manner of ingenuity in order to provide a sufficiency of food for their sustenance. Humboldt conjectures that the first idea of these floating gardens may have been suggested by nature herself, seeing that, "on the marshy banks of the lakes of Xochimilco and Chalco the agitated waters, in the time of the great floods, carry away pieces of earth covered with herbs and bound together with roots. The first Chinampas were mostly fragments of ground artificially joined together and cultivated." Following up this suggestion, it would not be difficult, by means of wicker-work formed with marine plants and a substratum of bushes combined with tenacious earth or clay, to construct similar gardens of adequate dimensions. Upon these was placed fine black mould sufficiently deep for the sustenance of the plants which it was desired to raise. The form usually given to these Chinampas was quadrangular, and their size varied from one hundred and fifty to three hundred feet in length, with a breadth of from twenty to seventy feet.

At first the use of these floating gardens was confined to the growth of maize and other objects of absolute necessity; but in the progress of time, and when the Mexicans had shaken off the yoke which rendered this restricted appropriation necessary, the owners of the Chinampas applied themselves to the production of vegetable luxuries, and grew fruits, and flowers, and odoriferous plants, which were used for the

embellishment of their temples and the recreation of their nobles. Daily at sun-rise, according to the Abbe Clavigero, were seen to arrive at the city of Mexico, innumerable boats loaded with various kinds of flowers and herbs, the produce of these floating islands. The garden is sometimes seen to contain the cottage of the Indian who is employed to guard a contiguous group of gardens; and on each one there is commonly erected a small hut, under which the cultivator can shelter himself from storms or from the intense heat of the sun. If it is wished to place the garden in a different place, this is easily effected by means of long poles, or by rowers placed in a boat to which the garden is fastened. In the driest seasons the Chinampas are always productive, and it is not difficult to renew the powers of the soil by means of mud taken from the bottom of the lake, and which is highly fertilizing. One of the most agreeable recreations afforded to the citizens of Mexico, is that of proceeding in small boats in the evening among these gardens, the vegetation upon which is always in a state of luxuriance.

Floating gardens are maintained also on some of the rivers and canals in China, where an excessive population produces the same effect as that just mentioned as having resulted from the oppression exercised upon the Aztecs by their Tepanecan conquerors; and the inhabitants are obliged to have recourse to every expedient for increasing the means of subsistence.

Of those emigrants who under ordinary circumstances take up their permanent residence in distant colonies, a large proportion is drawn from the agricultural classes. It is natural that these people should provide for their future comfort by conveying with them seeds of various plants, to the cultivation and use of which they have been accustomed in their native land. Accordingly we find, that in almost all places which have been colonized from Europe, the introduction of such vegetables has been attempted, and in this respect the condition of colonies frequently presents a fair evidence of the progress of horticulture in the parent state.

The Dutch, who found at the Cape of Good Hope no other fruits than the chestnut, a nut like the wild almond and the wild plum, and no culinary plants but a sort of vetch,* have rendered that colony, as regards its vegetable productions, one of the most interesting spots with which we are acquainted. Here are to be seen fruits and flowers, beautiful shrubs, and the most magnificent trees, all collected together from every climate and quarter of the globe, and all flourishing in the greatest perfection.

Our colonists in New South Wales have naturalized in that delightful climate nearly all the culinary vegetables which are to be found in this country, and in the market at Sydney some of these are to be seen in a state of greater perfection than can be given to them in this climate. The fruits of the South of Europe are likewise successfully cultivated, and pine-apples, together with many other productions of the tropics, are raised with as little trouble as attends the rearing of cucumbers and melons in this country.

* Loudon's Encyclopædia of Gardening, p. 108.

There are good reasons for believing that during the time of their ascendancy in Britain the Romans introduced various vegetable productions, together with the practice of their mode of gardening. This art never, however, attained to any degree of perfection in this country until the latter end of the seventeenth century, and it is probable that the greatest impetus which it ever received was given by the establishment of the Horticultural Society in 1805. By the exertions of this association, full advantage has been gained from the researches of travellers, and powerful incentives offered for the experiments of ingenious and scientific men.

At present, with the exception perhaps of Holland, there is no country where the use of gardens is so general as in our own. The humblest cottage is frequently seen to be surrounded by a small spot, whence may be drawn a wholesome and agreeable variety for the frugal board of the inhabitants; and even in towns, where the power of vegetation is scarcely able to withstand the effects of the confined and noxious atmosphere, a few yards of soil are often appropriated to the same purpose.

"The laborious journeyman mechanic," says Mr Loudon, "whose residence in large cities is often in the air rather than on the earth, decorates his garret window with a garden of pots. The debtor deprived of personal liberty, and the pauper in the work-house, divested of all property in external things, and without any fixed object on which to place their affections, sometimes resort to this symbol of territorial appropriation and enjoyment. So natural it is for all to fancy they have an inherent right in the soil, and so necessary to happiness to exercise the affections by having some object on which to place them."

The practical objects of the cultivator of vegetable substances, are—

1. To collect useful and ornamental plants from the domains of nature, and from all quarters of the world.

2. To adapt the soil, moisture, heat, and general culture suitable to such plants, so that they may vegetate to the full extent of their powers.

3. By artificial means, such as blanching and other processes, to change the nature and juices of plants, whereby they are rendered more esculent.

4. To produce new sorts or varieties of natural

species, by engrafting, budding, and other processes.

Soil. The soil which covers the surface of the earth, is composed of the pulverized matter of the different rocks, the primary ingredients of which are silex, alumina, lime, magnesia, iron, and a few other salts. This is called the primary soil, and according as either of the component ingredients preponderates, it may be sandy, clayey, calcareous, ferruginous, saline. The soil also contains a greater or less proportion of vegetable remains, such as the decomposed leaves and trunks of trees, or the peaty remains of cryptogamic and other marsh plants. Some soils, indeed, are almost entirely composed of vegetable remains, and constitute the rich dark mould, which, duly diluted, is esteemed the most fertile for the growth of vegetables. Some plants, however, thrive best in one kind of soil, and some in another. The object of the cultivator then, and especially of the horticulturist, is to adapt his soil for the particular kinds of plants he wishes to rear in perfection. Hence, the preparation of artificial soils. It is doubted by many, whether the pure earths afford any nourishment to plants; at all events, they enter but very sparingly into their composition. They serve, however, as a medium by which water, carbon, and some of the gases, are conveyed into their juices, and also as a convenient means by which the fibrous or bulbous roots are attached to, and held firm and stationary in, the ground. The true nourishment of plants is water and decomposing organic matter, whether vegetable or animal. The constituent parts of the soil which give tenacity and coherence, are the minutely divided particles, and they possess this power in the greatest degree if they be aluminous.

If the silicious or sandy particles are in excess, however, sterility is the consequence. Neither must the soil be too much comminuted; a certain proportion of coarser particles seems to be requisite. No one ingredient should be in excess in any fertile soil, not even an excess of organic matters: so that the best soil for general purposes is that where an equable admixture of the general ingredients is present, with a portion of the particles in a state of minute comminution.

Much of the fertility of soils depends upon their power of absorbing moisture from the air. When this power is great, the plant is supplied with moisture in dry seasons, and the effects of evaporation during the sunshine is compensated by the absorption of moisture at night. Stiff clayey soils which absorb a great proportion of rain-water are not, however, the best suited for absorbing it in dry weather, as the surface becomes hard and separates into deep fissures, which assist the evaporating effects from the interior. The best absorbing soils are those in which there is a due admixture of sand, clay, and lime, with animal or vegetable matter, and of a loose and light texture, freely permeable to the air and moisture.

Carbonate of lime, and animal and vegetable matter, are highly useful in this respect to soils: they impart an absorbent power without giving the soil too great tenacity. The absorbent power of soils ought to be adapted to the climate. In moist climates, a sandy light soil will be more productive than a deep clayey one, and the contrary. The subsoil also has a considerable effect in modifying the quantity of moisture. Shallow soils, situated on rocky ground, soon lose their moisture, while deep clay subsoils retain it for a long time.

Some soils absorb heat much more quickly and copiously than others, and also retain their heat longer. Black and brown mould has this property, while lighter clays and chalky soils are less absorbent of heat, the former giving it out again sooner than the latter.

Marshy soils, exposed to inundations and to continual evaporation, are colder and more ungenial than dry lands. The elevation above the sea level has also a very great effect on the temperature and on the growth of plants.

Digging, ploughing, and pulverizing the soil, and exposing the surface to the action of the summer sun and the winter's frost, are highly useful operations, by which the tenacity of stiff soils are overcome, weeds and insects are destroyed, and a quantity of air is admitted into its particles.

The rotation of crops is a well known practice among all vegetable cultivators. In order that vegetables may thrive vigorously, and become productive, it is necessary that their localities should be changed every other year. This is the case with the grains and many other plants, but does not take place with all vegetables, nor trees which are long lived. At one time it was supposed that vegetables exhausted the nutritive particles of the soil, if grown too long on one spot, and thus required a change; but as other vegetables requiring precisely the same kind of nutrition, are found to grow perfectly well if planted in succession to their predecessors of another kind, this theory was not deemed tenable. The prevailing theory now is, that plants give out from their roots an excrementitious matter, which, though noxious to individuals of the same species, may not be so to other families of plants. The experiments of M. Macaire demonstrate that plants do excrete noxious matters from their roots, perhaps analogous to the excrementitious matter of animals.*

Manure. The use of manure is to afford a supply of nutritive matter to plants. It has

* Edin. Philosoph. Journal, No. 28, p. 215.

been previously stated, that the elementary constituents of all vegetable bodies consist of oxygen, hydrogen, and nitrogen gases, with carbon, and a few of the earthy salts, and it must be evident that substances furnishing these elementary matters, and in a condition best suited for absorption by the organs of plants, are those best adapted as manures.

Animal and vegetable substances in a state of decomposition, and some earthy and saline matters, constitute the different kinds of manure. According to the experiments of Sir H. Davy,* all substances entering into the composition of vegetable manure or food, must be in a state of fluidity, or in the form of gas or air. The great object, therefore, in the application of manure, should be to make it afford as much soluble matter as possible to the roots of the plant, and that in a slow and gradual manner, so that it may be entirely consumed in forming its soft and organized parts.

Mucilaginous, gelatinous, saccharine, oily and extractive fluids, carbonic acid, and water, are substances that, in their unchanged state, contain almost all the principles necessary for the life of plants; but there are few cases in which they can be applied as manure in the pure form, and vegetable manures in general contain a great excess of fibrous and insoluble matter, which must undergo chemical change before it can become the food of plants. The nature of the chemical changes in these substances may thus be briefly stated. If any fresh vegetable matter which contains sugar, mucilage, starch, or other of the vegetable compounds soluble in water, be moistened and exposed to air, at a temperature from 55° to 80°, oxygen will soon be absorbed, and carbonic acid formed, heat will be produced, and elastic fluids, principally carbonic acid, gaseous oxide of carbon, and hydro-carbonate, will be evolved; a dark-coloured liquid, of a slightly sour or bitter taste, will likewise be formed; and if the process be suffered to continue for a time sufficiently long, nothing solid will remain, except earthy and saline matter, coloured black by charcoal. The dark coloured fluid formed in the fermentation always contains acetic acid, and when albumen or gluten exists in the vegetable substance, it likewise contains volatile alkali. In proportion as there is more gluten, albumen, or matters soluble in water in the vegetable substances exposed to fermentation, so in proportion, all other circumstances being equal, will the process be more rapid. Pure woody fibre alone undergoes a change very slowly, but its texture is broken down, and it is easily resolved into new aliments, when mixed with substances more liable to change, containing more oxygen and hydrogen. Volatile and fixed oils, resins, and wax, are more susceptible of change than woody fibre, when exposed to air and water, but much less liable than the other vegetable compounds; and even the most inflammable substances, by the absorption of oxygen, become gradually soluble in water. Animal matters in general are more liable to decompose than vegetable substances, oxygen is absorbed, and carbonic acid and ammonia formed in the process of their putrefaction. They produce fœtid compound elastic fluids, and likewise azote; they afford dark coloured acid and oily fluids, and leave a residuum of salts and earths, mixed with carbonaceous matter.

The principal substances which constitute the different parts of animals, or which are found in their blood, their secretions, or their excrements, are gelatine, fibrin, mucus, fatty, or oily matter, albumen, urea, uric acid, and other acid, saline, and earthy matters.

Whenever manures consist principally of matter soluble in water, it is evident that their fermentation or putrefaction should be prevented as much as possible, and the only cases in which these processes can be useful, are when the manure consists principally of vegetable or animal fibre. The circumstances necessary for the putrefaction of animal substances, are similar to those required for the fermentation of vegetable matters—a temperature above the freezing point, the presence of water, and of oxygen, at least in the first stage of the process. To prevent manures from decomposing, they should be preserved dry, defended from the contact of air, and kept as cool as possible. Salt and alcohol appear to owe their power of preserving animal and vegetable substances to their attraction for water, by which they prevent its decomposing action, and likewise to their excluding air.

We shall here enumerate a few of the different kinds of manures. All green succulent plants contain saccharine or mucilaginous matter, with woody fibre, and readily ferment. Such should therefore, if intended for manure, be used as soon as possible after their death. Hence the advantage of digging in green crops, whether natural or sown on purpose; they must not, however, be turned in too deep, otherwise fermentation will be prevented by compression and exclusion of air. Green crops should be dug in, if it be possible, when in flower, or at the time the flower is beginning to appear; for it is at this period that they contain the largest quantity of easily soluble matter, and that their leaves are most active in forming nutritive matter. Green crops, bind weeds, or the parings of hedges or ditches, require no preparation to fit them for manure, nor does any kind of fresh vegetable matter. The decomposition slowly proceeds beneath the soil, the soluble matters are gradually dissolved, and the slight fermentation which goes on,

* Agricultural Chemistry.

checked by the want of a free communication of air, tends to render the woody fibre soluble, without occasioning the rapid dissipation of elastic matter. When old pastures are broken up and turned into garden ground, not only has the soil been enriched by the death and slow decay of the plants which have left soluble matters in the soil, but the leaves and roots of the grasses living at the time, and occupying so large a part of the surface, afford saccharine, mucilaginous, and extractive matters, which become immediately the food of the crop, and from their gradual decomposition afford a supply for successive years.

Rape cake and *lintseed cake* contain a large quantity of mucilage, some albuminous matter, and oil. This kind of manure should be used recent, and kept as dry as possible before it is applied.

Malt dust consists chiefly of the incipient germ which is separated from the grain, in the process of turning and drying the malt. It is a strong manure, probably from containing a portion of saccharine matter, and, like the last, should be used in its recent and dry state.

Sea weeds. The different kinds of *fuci*, *algæ*, and *coniferæ* are largely employed as manures on the sea coasts of Britain and Ireland. In the north of Scotland and Orkney islands, the sea tang *(fucus digitatus,)* is generally used on account of its greater substance. When driven on shore by the winter storms or gales of spring, it is collected and laid on the land, and then ploughed down. It is a powerful manure, but its benefits do not extend beyond one, or at most two seasons. By dilution in water, the fuci yield a large proportion of mucilage and by distillation water, but no ammonia; the residue contains carbonaceous matter, with sea salt and carbonate of soda. Sea weed is sometimes suffered to ferment before it is used, but this process seems wholly unnecessary, for there is no fibrous matter rendered soluble in the process, and a part of the manure is lost. The best method is to use it as fresh as it can be procured. Some sea weed which had been fermented, so as to have lost about half its weight, afforded less than one-twelfth of mucilaginous matter; from which it may be fairly concluded, that some of this substance is destroyed in fermentation.

Peat earth. This substance remains for years exposed to water and air without undergoing change, and in this inert state yields little or no nourishment to plants. Mere woody fibre will not decompose, unless some substances are mixed with it, which act the same part as the mucilage, sugar, and extractive or albuminous matters with which it is usually associated in herbs and succulent vegetables. Thus, a mixture of common farm-yard dung and peat earth will ferment readily, or any other species of putrescible substance will answer the same purpose. One part of dung is thus found to promote the fermentation of three parts of peat. In cases in which living vegetables are mixed with the peat, the fermentation will be more readily effected.

Tanners' spent bark, wood shavings, or other vegetable fibre, will probably require as much dung to bring them into fermentation as the worst kinds of peat. Woody fibre may also be prepared so as to become a manure by the action of lime.

Wood ashes imperfectly formed, that is, containing much charcoal, are said to have been used with success as a manure. A part of their effects may be owing to the slow and gradual consumption of the charcoal, which seems capable under other circumstances than those of actual combustion, of absorbing oxygen so as to become carbonic acid. Yeast is one of the most powerful and durable of manures, but from its expense can of course be little used in this way. It imparts a very vivid green to auriculas.*

Animal manures. These substances in general require no chemical preparation to fit them for the soil. The great object is to blend them with the earthy constituents in a proper state of division, and to prevent their too rapid decomposition. Horses, dogs, or other large animals that have died, should be covered up with five or six times their bulk of soil, mixed with one part of lime, and allowed to decompose in this way for a few months, till the soil is impregnated with fertilizing juices. At the time of digging up this dunghill, the addition of a little quicklime will destroy the nauseous smell.

Fish. These also afford a rich manure, and should be applied to the ground as soon as possible, as their decomposition is more rapid than that of land animals. The quantity, however, should be limited.

A. Young records an experiment, in which herrings spread over a field and ploughed in for wheat, produced so rank a crop, that it was entirely laid before harvest. The refuse of pilcherds are used in Cornwall, mixed with sand and soil; and in Lincolnshire and other marshy counties of England, the common stickleback, found in abundance in the shallow waters, is used for a similar purpose.

Bones of animals are now much used as a manure both in England and Scotland, and their use is spreading rapidly over the continent. They are ground in a mill, and reduced to a coarse powder, and then strewed on the soil. This substance is best adapted for a dry soil.

Horn, hair, and the refuse of skin and leather manufactures, are all useful manures.

Urine, blood, and other liquid animal matters, if preserved in pits or boxes, also prove highly

* Loudon.

stimulating food for vegetables. To this may be added, the excrements of animals. Horse and cow dung is usually allowed by practical agriculturists to ferment and rot before it is applied to the land; though Sir H. Davy, on chemical principles, recommends all such to be used in a recent state. The dung of birds, especially of those that feed on animal matter, is reckoned highly stimulating manure.

Lime. Calcareous and saline matters are much employed in vegetable culture.

"Some inquirers," says Sir H. Davy, "adopting that sublime generalization of the ancient philosophers, that matter is the same in essence, and that the different substances considered as elements by chemists, are merely different arrangements of the same indestructible particles, have endeavoured to prove, that all the varieties of the principles found in plants may be formed from the substances in the atmosphere, and that vegetable life is a process in which bodies, that the analytical philosopher is unable to change or to form, are constantly composed and decomposed. But the general result of experiments are very much opposed to the idea of the composition of the earths, by plants from any of the elements found in the atmosphere or in water, and there are various facts contradictory to the idea." Jacquin states, that the ashes of glasswort, *(salsola soda,)* when it grows in inland situations, afford the vegetable alkali; when it grows on the sea-shore, where compounds which afford soda are more abundant, it yields this alkali. Duhamel found that plants which usually grow on the sea-shore, made small progress when planted in soils containing little common salt. The sun-flower, when growing in lands containing no nitre, does not afford that substance, though, when watered by a solution of nitre, it yields nitre abundantly. The table of De Saussure shows that the ashes of plants are similar in constitution to the soils in which they have vegetated. This philosopher made plants grow in solutions of different salts, and he ascertained, that in all cases certain portions of the salts were absorbed by the plants, and found unaltered in their organs. Even animals do not appear to possess the power of forming the alkalies and earthy substances. Dr Fordyce found that when canary birds, at the time they were laying eggs, were deprived of access to carbonate of lime, their eggs had soft shells. Yet, according to the chemical analysis of Dr Marcet, the quantity of phosphate and carbonate of lime found in the bones of the chick, is much more than that previously existing in the contents of the egg, or the loss sustained by the shell.

Lime, from its strong attraction for carbonic acid and moisture, may thus also be beneficial, by affording a supply of both these to plants. Lime exists in nature, and in the soil, in a state of combination with carbonic acid. Limestone, however, before it can be rendered friable, must first be burnt and reduced to a quick or caustic lime. In this state, on the addition of water, it readily pulverizes, and greedily absorbs carbonic acid from the atmosphere. Very few limestones or chalks, however, are pure, the primary marbles and calcareous spars being the exception. Clay, flint, magnesia, iron, and other salts, are in greater or less quantity found mixed in limestones. Slacked lime is a combination of lime with about a third of its weight of water, and is called a *hydrate* of lime, and when this hydrate becomes, by exposure to air, a carbonate, the excess of water is expelled. When freshly burned or slacked lime is mixed with any moist fibrous vegetable matter, there is a strong action between the lime and the vegetable matter, and they form a kind of compost together, of which a part is usually soluble in water. By this kind of operation, lime renders matter, which was before comparatively inert, nutritive; and as charcoal and oxygen abound in all vegetable matters, it becomes, at the same time, converted into carbonate of lime. Mild lime, powdered limestone, marls, and chalk, have no action of this kind upon vegetable matter; they destroy worms and other tender-skinned vermin, and they prevent the too rapid decomposition of substances already dissolved, but in other respects their operations are different from that of quick lime. Lime, marls, and even shell-sand, produce wonderful effects on peat soils, by absorbing the gallic acid which they contain, and promoting the decomposition of the woody matters.

All soils having a deficiency of calcareous earth, and which do not effervesce with acids, are improved by lime, either mild or quicklime. Sandy soils are improved more than clay. When a soil deficient in calcareous matter contains much soluble vegetable manure, the application of quick lime should always be avoided, as it either tends to decompose the soluble matters, by uniting to them carbon and oxygen, so as to become mild lime, or it combines with the soluble matters, and forms compounds, having less attraction for water than the pure vegetable substance. The case is the same with regard to most animal manures, but the operation of the lime is different in different cases, and depends upon the nature of the animal matter. Lime forms a kind of insoluble soap with oily matters, and then gradually decomposes them, by separating from these oxygen and carbon. It combines likewise with the animal acids, and probably assists their decomposition, by extracting carbonaceous matter from them, combined with oxygen, and consequently it must render them less nutritive. It tends to diminish likewise the nutritive powers of albumen from the same

causes, and always destroys, to a certain extent, the efficacy of animal manures, either by combining with certain of their elements, or by giving to them new arrangements. Lime should never be applied with animal manures, unless they are too rich, or for the purpose of preventing noxious effluvia. It is injurious when mixed with common dung, and tends to render the extractive matter insoluble; and with almost all soft animal and vegetable substances, lime forms insoluble composts, and thus destroys their fermentative properties. Such compounds, however, exposed to the continued action of the air, alter in course of time, the lime becomes a carbonate, and the animal and vegetable matter enter by degrees into new compounds suited for vegetable nourishment. In this view, lime presents two great advantages for the nutrition of plants; the first, that of disposing certain insoluble bodies to form soluble compounds; the second, that of prolonging the action and nutritive qualities of substances beyond the term, during which they would be retained, if these substances were not made to enter into combination with lime.

Impure lime, where the mixture is clay or silex, is less efficacious in proportion to the admixture, but these substances are not deleterious.

Magnesia, on the other hand, has been deemed hurtful to corn crops, although it may be found advantageous in mixing with peat soils. Carbonate of magnesia is deemed a useful constituent of soils.

Gypsum, or sulphate of lime, has been sometimes applied as a manure, but the exact nature of its effects has been a subject of controversy. It has been supposed by some persons to act by its power of attracting moisture from the air; but this agency must be apparently insignificant. When combined with water, it retains that fluid too powerfully to yield it to the roots of the plant, and its adhesive attraction for moisture is inconsiderable; the small quantity in which it is used is also a circumstance hostile to this idea. It has been erroneously said, that gypsum assists the putrefaction of animal substances and the decomposition of manure. The ashes of saintfoin, clover, and ryegrass yield considerable quantities of gypsum, and for such crops it is well suited. The reason why gypsum is not generally efficacious, is probably because most cultivated soils contain it in sufficient quantities for the use of the grasses. In the common course of cultivation, gypsum is furnished in the manure, for it is contained in stable dung, and in the dung of all cattle fed on grass, and it is not taken up in corn crops, or crops of peas and beans, and in very small quantities in turnip crops; but where lands are exclusively devoted to pasturage and hay, it will be continually consumed.

Phosphate of lime is a compound part of animal and vegetable bodies; it is insoluble in pure water, but is soluble in water containing any acids. It constitutes the greater part of calcined bones. It exists in most excrementitious substances, and is found both in the straw and grain of wheat, barley, oats, and rye, and likewise in beans, peas, and tares. Phosphate of lime is generally conveyed to the land in the composition of other manure, and it is probably necessary to corn and other crops.

Wood ashes consist chiefly of potass united to carbonic acid; and as this is found in almost all plants, its efficacy as an ingredient of the soil is obvious.

Common salt, which is a chloride of soda, is also occasionally used as a manure. According to Sir John Pringle, salt in small quantities assists the decomposition of animal and vegetable matter.

Soot contains ammonia, an empyreumatic oil, and carbon or charcoal; it thus affords a powerful manure. On the whole, Sir H. Davy is of opinion, that except the ammoniacal compounds, or the compounds containing nitric, acetic, and carbonic acid, none of the saline substances can afford, by decomposition, any of the common principles of vegetation. The alkaline sulphates, and the earthy muriates, are so seldom found in plants, or are found in such minute quantities, that it never can be an object to apply them to the soil. The earthy and alkaline substances seem never to be formed in vegetation, and there is every reason to believe, that they are never decomposed; for after being absorbed, they are found in the ashes. The metallic bases of these cannot exist in contact with aqueous fluids, and these metallic bases, like other metals, have not as yet been resolved into any other forms of matter by artificial processes. They combine readily with other elements, but they remain indestructible, and can be traced undiminished in quality through their diversified combinations.

The fermenting substances used in forming hot beds are, stable litter or dung in a recent or fresh state, tanner's bark, leaves of trees, grass, and the herbaceous parts of plants generally. Stable dung is in the most general use for forming hot beds, which are square masses of this dung after it has undergone violent fermentation. Tanners' bark is only preferred to dung, because the substance which undergoes the process of putrid fermentation requires longer time to decay. Hence it is found useful in the bark pits of hot houses, as requiring to be seldomer removed or renewed than dung, or any other known fermentable substance that can be procured in equal quantity. Leaves, and especially oak leaves, come the nearest to bark, and have the additional advantage, that when perfectly rotten like dung, they form a rich mould or

excellent manure, whereas rotten tanners' bark is found rather injurious than useful to vegetation, unless well mixed with lime and earth.

In preparing manures for hot beds, the object is to modify the excessive heat generated in the first process of fermentation. For this purpose, a certain degree of moisture and air in the fermenting bodies are requisite; and hence, they require to be turned over frequently, and a supply of water given when the process appears retarded for want of it, or water and rain excluded when the fermentation is too languid, in consequence of a chill state of the mass. Recent stable dung generally requires to lie a month in ridges or beds, and to be turned over in that time thrice before it is fit for cucumber beds of the common construction; but for common beds, three weeks, a fortnight, or less, will suffice, or no time at all need be given, but the dung formed at once into linings. Tan and leaves require in general a month, but much depends on the state of the weather and the season of the year. Fermentation is always most rapid in summer, and if the materials are spread abroad during frost, it is totally impeded. In winter, the process of preparation generally goes on under cover from the weather in the back shades, which situation is also the best in summer, as full exposure to the sun and wind dries too much the exterior surface; but when sheds cannot be had, it will go on very well in the open air. A great deal of heat is undoubtedly lost in the process of fermentation, and some cultivators have recently devised plans to turn it to some account, by fermenting dung in vineries which are just beginning to be forced, or in vaults under pine pits or plant stores.

Sowing seeds. After the soil is properly dry and pulverized the seeds are deposited, and this should always be done in dry weather, for a dry soil is especially requisite for covering in the seeds. Small seeds are sown in greater or less quantity, according to the kind. Some are planted singly, as beans, potatoes; and the depth at which they are covered in, much depends upon the kinds of plants. Some seeds require a mere sprinkling of earth, others have to be covered up with one, two, or three inches of mould, especially if planted at times when frost occurs. In general, however, as germination requires air and heat, the seeds should not be more than covered with the soil.

Watering. This process is often necessary, especially in horticulture, as a means of nourishment to growing plants, especially as a support to newly transplanted vegetables, and for cleaning the leaves and destroying insects. Water should never be thrown over the leaves of plants when the sun shines. Indeed, watering should always be practised either in the evening or the morning, as during sunny days, the sudden evaporation of water causes a chill which is fatal to vegetation.

North and east winds, which are generally chill and dry, are most inimical to vegetation, and during such times, plants in the open air should be watered with circumspection. The process should be done in the evening, and shelter or matting put over tender plants. While south and westerly winds prevail, even although no rain should fall, vegetables are not in such need of water, as the air at those times is full of moisture, and the soil readily absorbs this fluid from the air. In transplanting vegetables, a liberal supply of water is necessary, and they should be shaded from the sun; a glass bell or a close frame put over such plants, serves to prevent too great an evaporation from their leaves, and gives time for the roots to resume their action. In large rooted and hardy plants, the superfluous and bulky parts, and even portions of the small rootlets, may be dressed away; but in transplanting smaller and more delicately rooted plants, the minute fibres should be carefully preserved, and placed in a natural position among the soft mould. It is in the action of these rootlets chiefly, that the vigorous growth of the plant depends. In transplanting into pots, the general practice is, to begin with the smallest-sized pot, and gradually to transplant into others larger, as the plant advances, and as the object may be to produce a large or a small plant. In the case of balsams and tender annuals this may require to be done three or four times a month, till the plant has attained its full size; in the case of heaths, not more than once a year or seldomer.

Pruning is the amputation of branches of trees, in order to repress too great growth, and to direct the sap to other branches. Of two adjoining and equal sized branches of the same tree, if the one be cut off, that remaining will profit by the sap which would have nourished the other, and both the leaves and the fruits which it may produce, will exceed their natural size. If part of a branch be cut off which would have carried a number of fruits, those which remain will sit or fix better, and become larger. The objects of pruning them may be the promotion of growth and bulk, lessening bulk, modifying form, promoting the formation of blossom buds, enlarging fruit, adjusting the stem and branches to the roots, renewal of decayed plants or trees, and removal or cure of diseases.

Grafting. This is a process applicable to all trees and shrubs, and even smaller plants, and consists in inoculating or joining one branch of a species to another, and thus producing a variety different from either. A grafted tree consists of two parts, the scion and the stock. The scion

* Loudon's Ency. of Gardening.

is a part of the living vegetable, which united or inserted in a stock identifies itself with it, and grows then as on its natural stem and roots. The scion and stock must be either of identical species, or of the same genera, or genera of the same natural family, otherwise the graft will not succeed. It was formerly a popular opinion that any scion would succeed on any stock. Thus Pliny, Varro, and Columella, speak of apples and vines grafted on elms and poplars; and Evelyn mentions, that he saw a rose grafted on an orange tree in Holland. The ancients acknowledge, however, that such grafts were of very short duration; and Professor Thouin remarks, that the result of numerous experiments made by him, proves that if any one of these grafts seems at first to succeed, they all perish in a very short period.

The periods of the movement of the sap in different species of trees, the permanence, or time of falling of their leaves, and the periods of maturation and qualities of the fruits, are circumstances to be taken into consideration in making grafts.

Grafting may be performed on all herbaceous vegetables with solid stems. Georgina roots are frequently grafted in this country; and in France, melons have been grafted on cucumbers, love apples on potatoes, and cauliflowers on cabbages.

Grafting may be performed with scions of the current year's shoots, or with those of several years growth. The stock does not change the character of the species of the scion which may be grafted on it, although it materially affects the quality of the fruit. Some kinds of stocks are more adapted for grafting than others. The great art of grafting is to unite exactly the inner bark of the scion with the inner bark of the stock, and thus to keep them in contact, till a union takes place.

Whip or tongue grafting. To effect this process in the most perfect manner, it is desirable that the top of the stock and the extremity of the scion should be of equal diameter. Hence, this kind of grafting can be performed on smaller stocks than any other. The scion and stock being cut off obliquely at corresponding angles, as near as the operator can guess them, cut off the tip of the stock obliquely or nearly horizontally, a slit is now to be made nearly in the centre of the sloped face of the stock downwards, and a similar one in the scion upwards. The tongue or wedge-like process, forming the upper part of the sloping face of the scion, is then inserted downwards in the cleft of the stock, the inner barks of both being brought closely to unite on one side, so as not to be displaced in tying, which ought to be done immediately with a ribbond of bast brought in a neat manner several times round the stock, and which is generally done from right to left when the scion is placed with the right hand, but from left to right, when it is placed with the left hand. The next operation is to clay the whole over an inch thick on every side, from about half an inch or more below the bottom of the graft, to an inch over the top of the stock, finishing the whole coat of clay in a kind of oval globular form, closing it effectually about the scion and every part, so as the weather or light may not penetrate, to prevent which is the whole intention of claying. The French method of grafting differs from the English, in their never paring more off the stock, however large, than the width of the scion. In both modes, the stock is sometimes not shortened down to the graft, but a few inches left to serve as a prop to tie the shoots proceeding from the scion, or even to admit of fastening the ligatures used in the operation more securely.

In cleft grafting, the head of the stock or branch, which may be two or three inches in diameter, is first cut off obliquely, and then the sloped part is cut over horizontally near the middle of the slope; a cleft nearly two inches long is made with a stout knife or chisel in the crown downwards, at right angles to the sloped part, taking care not to divide the pith. This cleft is kept open by the knife. The scion has its extremity for about an inch and a half cut into the form of a wedge; it is left about the eighth of an inch thicker on the outer or bark side, and brought to a fine edge on the inside; it is then inserted into the opening prepared for it, and the knife being withdrawn, the stock closes firmly upon it. Two or more scions may be thus grafted into the same stock.

Crown grafting is practised chiefly in thick stocks, shortened branches, or headed down trees. In this operation the scion is inserted between the bark and the wood, and it is most successful when performed later than the others. First, cut or saw off the head of the stock or branch horizontally or level, and pair the stock smooth. Then cut one side of each scion flat and somewhat sloping, an inch and a half long, forming a sort of shoulder at the top of the slope to rest upon the crown of the stock; then raise the rind of the stock with the ivory wedge, forming the handle of the budding knife, so as to admit the scion between it and the wood two inches down; which done, place the scion with the cut side next the wood, thrusting it down far enough for the shoulder to rest upon the top of the stock, and in this manner may be put three, four, five, or more scions in one large stock or branch.

Side grafting differs from whip grafting, in being performed on the side of the stock without bending down. It is practised on wall trees to fill up vacancies, and sometimes in order to have a variety of fruits upon the same tree. Having

fixed upon those parts of the branches where wood is wanting to furnish the head or any part of the trees, slope off the bark and a little of the wood, and cut the lower end of the scions to fit the part as near as possible; then join them to the branch, tie them with bark, and clay them over.

In a month after any of the operations of grafting, it may be ascertained whether the scion has united with the stock, by observing the progress of its buds; but in general, it is not safe to remove the clay for three months or more, till the graft be completely cicatrised. The clay may generally be taken off in July or August, and at the same time the ligatures loosened, when the scion seems to require more room to expand; a few weeks afterwards, when the parts have been thus partially inured to the air, and when there is no danger of the scion being blown off by winds, the whole of the ligatures may be removed.

If the stock was not shortened down close to the graft or junction of the scion with the stock at the time of performing the operation, it may be done now, or as soon as the ligatures can be entirely dispensed with.

In particular cases, a ligature round the graft, or a stake or other prop for the shoots of the scion, may be necessary for a year to come, to protect against winds, or a bandage of moss may be kept over the graft to preserve moisture, and encourage the expansion of the parts and complete filling up of the wound.

Scions are generally taken from the young shoots of last summer's growth, and from the outside lateral branches. They should be gathered several weeks before the season for grafting arrives, as experience has shown that grafting may most successfully be performed by allowing the stock to have some advantage over the graft in forwardness of vegetation. It is desirable that the sap of the stock should be in brisk motion at the time of grafting.

Grafting clay is prepared either from stiff yellow or blue clay, or from clayey loam, well beat up with a fourth of horse dung and a little chopped hay. The French and Dutch use one half fresh cow dung free from litter, and one half fresh loam.

Budding or grafting by gems. This is performed by taking an eye or bud of a liqueous plant attached to a portion of the bark, and inserting it into the bark of another stem. This process may also be performed with herbaceous plants, but not so successfully. Budding is performed any time from the beginning of July to the middle of August, regulated by the time at which the bud is formed on the axillæ of the leaf of the current year. The buds are known to be ready by the shield or portion of bark to which they are attached easily parting with the wood. They should be gathered in a cloudy day, or in the evening, and used as soon as possible, although they may be sent to a considerable distance, preserved in moist moss.

In cutting off the bud, insert the knife half an inch below it, and cut upwards a slice of the wood along with the bark, to half an inch above the bud. The bud being thus disengaged, the woody part is to be carefully separated from the bark, and the bud examined, to ascertain that it is sound and perfect. A horizontal slit is next to be made in the tree or stock where the bud is to be inserted, and then another slit perpendicular, cutting in both cases through the bark into the wood, and forming an incision in shape of the letter T. The bark in the perpendicular slit is to be gently raised a little from the wood on each side, and the lower portion of the bark of the bud slipped into the opening; the upper portion of the bark is next to be cut across horizontally, corresponding to the horizontal cut or upper portion of the T, so as that the incised edge of both barks may come into exact contact. The wound is now bound round with a piece of wetted bast. This operation is sometimes practised by reversing the incision, thus ⊥.

Scallop budding is performed by paring a thin tongue-shaped portion of bark from the stock, and applying the bud, without divesting it of its portion of wood, so as that the barks of both may exactly fit, and tying it in the usual way. These buds generally adhere in a fortnight or three weeks, and may be known to have done so, by their fresh growing appearance.

Propagation by cuttings. This process is exceedingly simple and easy in the case of many trees, as the willows and poplars; but requires some management in the heaths, myrtles, and other shrubs. Cuttings are to be chosen from the side shoots of plants, especially those which show a tendency to droop towards the ground, and the proper time for doing this is when the sap is in full motion. The cuttings should contain a portion of last year's wood, or of wood so far formed, and after it has assumed its proper brown colour. Cuttings from herbaceous plants are chiefly taken from the low growths, but they will also succeed occasionally from the flower stems. The cuttings should be prepared, so as that the lower end terminates in a joint or bud when the leaves spring out, and the upper leaves should be left on the branch.

In plants difficult to strike, it is a general practice before cutting them off from the parent plant, to cut a ring round the bark, and after remaining on the parent branch for a short time, till a callus is formed, they are cut off below the ring and inserted into earth. Tender cuttings, when planted in pots, should be placed near the sides, not in the middle, with their lower ends touching the bottom of the pot, or resting

in sand or gravel. In this way they readily strike, whereas, if planted in the loam in the middle, they will fail.*

The cuttings should not be inserted to a great depth, and a moderate degree of heat, moisture, and light is preferable to any excess. A glass frame or handbell cover promotes their striking very considerably, by tending to promote an equilibrium of atmosphere and temperature. The degree of heat necessary, depends upon the nature of the plants. In general, cuttings during the process of striking require less heat than the vigorous parent plant. Cuttings of deciduous hardy trees taken off in autumn, should not be put into heat until spring, but should be kept dormant like the parent trees.

Piping is a mode of propagating used with herbaceous plants having jointed tubular stems, and has been already described when treating of the *Dianthus* and other garden flowers.

CHAP. LVIII.

DRYING AND PRESERVING PLANTS AND VEGETABLE SPECIMENS—WARD'S PORTABLE CONSERVATORY.

The formation of an herbarium of dried plants is an almost essential requisite for the botanist, and forms an interesting and highly useful reference to the student and the practical cultivator of plants.

The following directions are the results of the experience of an eminent botanist, Dr Greville.

Plants are preserved by placing them between sheets of absorbent paper, and then submitting them to pressure until they are quite dry. To dry plants is a very simple operation; and there are collectors who seem to think that, if all moisture is expelled, nothing more can reasonably be expected. This, however, is not sufficient for the purposes of science. The botanist must aim not only at retaining as much as possible the character, but the original beauty, of the plants he wishes to preserve. Continental botanists, especially the Germans, are celebrated for the beauty and completeness of their specimens; and the black, curtailed, and carelessly arranged vegetable remains which in this country are often dignified with the name of botanical specimens, are justly regarded by them as utterly worthless, and would equally be rejected by every one anxious to form a valuable collection.

Specimens should be taken (when practicable) in fine weather, and free from external moisture.

They should be in a perfect state of growth, their leaves and other parts uninjured. When, as is the case in some plants, the lower stem-leaves differ in shape from the upper ones, and the plant is too large to preserve entire, portions of the lower parts of the stem with the leaves, should be taken separately: if the root-leaves also differ, they, too, should be preserved. In some cases, it is important to have the young shoot with its fully developed leaves, as in the genus *salix*, where the stipules are deciduous; and also in the genus *rubus*, where the leaves, &c. of the barren surculi are most characteristic. In short, it should always be borne in mind, that a perfect specimen of any plant includes every characteristic part. Bad specimens are always to be rejected, unless the plant is of great rarity. Varieties are always interesting, as well as remarkable states and monstrosities, or deviations from the ordinary arrangement of any of the parts. In regard to the size of specimens, the best guide is the paper most generally used in good herbaria: this is about seventeen by ten and a half inches. No specimens should therefore exceed sixteen inches in length by nine and a half inches in breadth. Plants under this size should invariably have the root attached. It may be laid down as a general rule, that the entire plant should be taken, if, by a little management, it can be brought within the above-mentioned limits. Grasses, carices, and plants of a slender habit, may be folded once or twice backwards and forwards, if necessary; and long slender ferns, &c., may in this manner be preserved without mutilation. When it is inconvenient to obtain the root, the stem should be separated below the insertion of the root-leaves. The young collector is reminded, that specimens in fruit are to be selected as well as those in flower.

The apparatus requisite for collecting and preserving plants are,

The *Digger*. This is a sort of trowel seven or eight inches long; the spud two and a half inches long, two and a half inches wide at the top, narrowing gradually to two inches at the bottom, the lower angles slightly rounded. It should be made sufficiently strong, to resist considerable force in digging out plants from the crevices of rocks, &c.

The *Vasculum or botanical box*. The diligent collector will find it convenient to have his boxes of two or three sizes. One of them should be small enough for the pocket, and is very useful for the reception of small and delicate plants, and such objects as demand peculiar care. The principal vasculum, for distinction's sake, we call the *magnum*. It should not be less than twenty inches long, eight or nine inches wide, and five inches deep, having a strong handle at one end. The form most strongly recommended is a flattened oblong, convex on both the upper and under side, the curve of the lid being similar to that

* Knight.

of the under surface. The *magnum* is, of course, only required on excursions when a considerable number of specimens are desired. On such occasions, it is indispensable, if the collector wishes to bring home his plants in a satisfactory state. In boxes intended for the pocket, and in them only, the common concave form of the lid may be retained with advantage.

The *Field-book.* This may be carried or not, according to circumstances. It may be made of any size, from that of a large pocket-book to a folio, and is in fact nothing more than a portfolio, containing a quantity of absorbent paper, temporary pressure being given by a couple of straps. To the inner edge of one side is attached a piece of oiled silk, as well as to each end, which serves to keep the paper dry in case of rain. If the field-book is of a quarto or folio size, it may be slung over the shoulder by a strap, on the side unoccupied by the vasculum. The great use of such a book is, that plants having very deciduous flowers, the *Veronica saxatilis* for example, may be at once exposed to some degree of pressure. Some plants also, whose corollas close almost immediately after being gathered, such as those of the different species of *erythræa*, can only be preserved in their beauty by being placed in paper on the spot. In a long day's excursion, where the harvest is likely to be abundant, the field-book will be found extremely useful.

Paper. The best paper for the process of drying plants is a kind known by the name of demy grey, with a tolerably smooth surface, eighteen inches long by eleven inches broad, which is the size found by experience to be most convenient, not only for the resident but the travelling botanist. It may be purchased for seven or eight shillings per ream, and is preferable to common blotting paper, in being very much cheaper, far more durable, and in drying more rapidly after having been used—a point of considerable importance, especially on botanical excursions, when large quantities have to be dried daily, and sometimes under very disadvantageous circumstances. A limited quantity of very thin white paper, of the same size as that described above, will be found useful in preserving some plants, which become soft and flaccid during the process of drying, and which cannot be transferred from one sheet of paper to another without injury. The corolla of *viola lutea*, for example, collapses, if removed in the ordinary way, after a day's pressure. By placing such plants at first within the sheet of thin paper, the whole sheet, plants and all, can be moved when the drying paper requires to be changed, without their being disturbed.

Boards. Two kinds of boards must be procured, both of which should be exactly the size of the paper, or, at most, a quarter of an inch larger each way. Two of the boards should be double ones, half or three-quarters of an inch thick; each double board being composed of two thin ones, the grain of the one crossing that of the other, firmly glued together, and further secured by small screws along the edge, at intervals of three inches: the rest of the boards, say eight in number, should be three-eighths of an inch thick. These ten boards form a set, and will serve for a couple of reams of paper. If the collector is active, he will require several sets of boards, and paper in proportion.

Press. Some botanists employ screw or other presses. A preferable and simpler plan is to use common iron weights, or a squared stone having an iron ring fixed in the centre. By this means, the pressure is never relaxed, as is the case with the screw-press. In preserving bulky plants, it is sometimes difficult to equalize the pressure. Paper folded to the required thickness, and placed on each side of the stem, is frequently sufficient for the purpose. In more difficult cases, a sand-bag or two, of the size of the paper, may be used with advantage. In travelling, each parcel of paper containing plants must be secured by three strong straps, a double board being placed above and below, and in this way a considerable degree of pressure may be obtained. When the botanist is stationary for several days on an excursion, or even resting for a single night, no better resource can be desired than a few heavy stones. A weight of 100 lbs. will not be too much to place upon each parcel.

A pair of common surgeon's forceps are very useful in removing small plants from one sheet of paper to another. A second pair, as well as an extra knife, will be provided by the experienced traveller, in case of accidents. If an excursion of some days is contemplated, a good supply of strong cord, and several spare straps, should not be omitted; and every parcel of paper should be completely enveloped in oilcloth (before the boards are strapped on,) to prevent the paper or its contents from being injured by wet.

The botanist being now provided with his *materièl*, I shall suppose him to have commenced a ramble of a few days. He has already been tempted to deposit some fine specimens of very common plants in his vasculum; but let not this provoke a smile, for it is not a bad rule to take even a very common plant, when a remarkably fine or beautiful specimen presents itself. But as our botanist has commenced operations, I shall now address myself to him, and offer a few hints for his guidance. Be very particular in the first place, in the choice of specimens: put nothing into your box that is not good of its kind. Let the specimens be the proper size for preserving, and dispose them carefully, so as not to injure each other. Clean the roots before you

place them in the box, and wash those which have been gathered in muddy places. If you have been very successful, and your box begins to show symptoms of repletion, sit down and revise its contents; throw away the inferior things, and retain nothing but what is really worth preserving. You will thus bring home your collection in a good state, although you may have, perchance, (no uncommon thing in the Scottish Highlands,) to walk a dozen miles to your quarters. If the sun is very powerful, cover your specimens with a few large leaves, or even a little grass, and sprinkle a few drops of water over them. Having returned with your treasures, you will be anxious to commit them to paper. Provide yourself with a number of slips of paper, two inches long by one inch broad, with a slit half an inch in length cut in the centre, and have your knife and forceps at hand. Place now half a dozen sheets of paper upon one of the double boards, and proceed to lay out your specimens; one or more on the same sheet, according to their size. It is not desirable that the branches, leaves, &c., should be artificially displayed: separate them slightly, if they require it, and take care that the parts are not unnaturally bent or folded. Long slender plants, however, that require to be folded, must have the folded extremity passed through the slit of one of the paper slips, which will keep the parts in their proper position. Lay down your specimens (as a general rule) with their roots towards you, and as you place five or six sheets of paper upon them, arrange the leaves, &c., with your hand or the forceps, and then proceed with other specimens, until you have a dozen or more sheets of them arranged. Cover them, then, with one of the thin boards, and begin another series, and so on until all your plants are secured. Place the other double board upon the top, and submit the whole to pressure. The above directions are sufficient for the preservation of most plants: there are some, however, which demand particular treatment. If the specimens are woody, or very thick in the stem, a slice can often be taken from the back without affecting the character of the plant: a portion of the plant may be removed if it is densely tufted; and some of the branches of the back in such plants as *hippophäe rhamnoides*, *prunus spinosa*, &c. Robust plants that yield but slightly to pressure, *statice armeria* for example, and others which do not yield at first to pressure, require a thin board to be placed between every sheet of specimens. The stone-crop tribe must be plunged for some minutes into boiling-hot water, and then pressed between coarse napkins until the external moisture be removed, before they are committed to paper: unless this be done, the plants will live for a month under pressure, and the leaves die and fall off by degrees. Aquatic plants should also be freed from external moisture by means of napkins, and the same plan may be advantageously resorted to when specimens are collected in wet weather, which is sometimes inevitable. Orchideous plants must be subjected to great pressure, and ought to be dried very rapidly: scarify the back of the stem, and the midrib on the back of each leaf with a knife, in order that the juice of the plant may have an outlet by which to escape: separate the flowers also, by inserting small pieces of paper between them. When plants have large and delicate corollas, place a piece of thin paper, somewhat larger than the corolla, above and below it, to remain until the specimens are dry. The quantity of paper to be placed between each sheet of specimens will vary according to circumstances. For plants of a thin texture, and containing little moisture, five or six sheets are sufficient; but more is necessary for succulent kinds, for aquatic plants, and for plants in general, when gathered in wet weather; likewise for woody and robust specimens.

In regard to the frequency with which the paper ought to be changed, this, for ordinary plants, is a daily operation, and ought on no account to be omitted, until they are very nearly dry. Aquatic and very succulent plants should be transferred to dry paper twice a-day; and the species of *sedum*, &c., which have been plunged into hot water, several times during the first and second days, as the moisture is given out very rapidly. Change the paper in which orchideous plants are drying twice a-day, and let it also be well heated. If you are stationary, and have plenty of paper, slender plants, like many of the grasses, &c., and others containing very little moisture, like *myosotis collina* and *versicolor*, &c. may be allowed to remain in the paper after having received a single change, until they are dry, two or three extra sheets being placed between the specimens. In giving your specimens their first change of paper, you will not omit to rectify any mistake in their disposition, and place those leaves right that have been accidentally folded, &c.

On the second day of your excursion, you will have a quantity of damp paper on your hands. In some places it is easy enough to get it dried, but in the little inns of mountainous districts, the difficulty of getting several reams of damp paper dried daily, at first sight appears insurmountable. Nothing, however, is more readily effected, provided you wait upon yourself. Having brought a roll of thick cord (and a score of strong nails in case they should be wanted,) fix one end of the cord to the roof of the kitchen, and carry it backwards and forwards along the roof as many turns as you require. Hang your paper on these ropes in parcels of a few sheets

before you leave your quarters in the morning, and by the time you want them in the evening they will be thoroughly dry. Another set may be dried during the night.

As the plants become dry, they may be arranged close together, but so as not to touch each other, on single sheets of perfectly dry paper, and kept in parcels by themselves. When a considerable number of plants are in process of drying, those in the different stages of the process should be kept apart from each other, in order that the desiccation of the more advanced specimens may not be retarded by the juxtaposition of those more recently collected.

Invariably attach labels to your specimens, mentioning the particular station, the date of collection, elevation above the sea, (as nearly as it can be estimated,) the geological formation of the locality, and any additional information that may be interesting.

Many cryptogamous plants do not necessarily require the same care when first collected as those about which I have been speaking, as they can be relaxed by moisture and prepared at any subsequent period. They will, perhaps, lose somewhat of their original bright colour; but this is of trifling importance, if the great saving of time to the collector, especially in foreign countries, be considered.

Mosses and *hepaticæ* may be gathered in tufts, or masses of considerable size, always selecting such as are in fructification. If the stems or roots are loaded with mud or soil, they should be well washed. The tufts are then to be placed between sheets of coarse paper, and dried under a moderate pressure, after which they may be packed like other plants. In subsequently preparing specimens for the herbarium, a greater pressure will be required.

Lichens may be treated like mosses, at least such kinds as admit of pressure. Those species which form a close crust on rocks, trunks of trees, &c., and which can only be obtained along with a portion of the substance on which they grow, should be wrapped separately in paper, like minerals, and packed into a box.

Algæ or *sea-weeds* are preserved in a rough state with much facility, and, on account of the increasing interest which attaches to them, should be assiduously collected in foreign countries, especially in the southern hemisphere. They should be taken, if possible, with the root, and will often be found in the highest state of perfection thrown on shore by the tide. All kinds should be taken, from the smallest, to the largest manageable size; avoiding those specimens which are battered, or in a state of decomposition. Spread them on the ground, or in an outhouse to dry, without washing them in fresh water, in fact, just as they are gathered; and when they are quite dry, pack them without pressure into a box, mixing a few small branches with them, to prevent them from being pressed too much together, in case of damp on the voyage.

For the preservation of fruits and other botanical specimens in the moist state, Professor Christison says, that after numerous experiments made for a series of years with various fluids, he finds none which serve so well to preserve both the consistence and colour of fruits, leaves, and flowers, as a concentrated solution of common salt. The solution should be made with the aid of a boiling heat, otherwise it can with difficulty be obtained sufficiently concentrated. When articles are to be sent to a distance, as when specimens are transmitted from hot climates to this country, the best mode of putting them up is to preserve those which are of small size in green glass bottles, such as are used for pickles, to fill the bottles with the solution, and to secure the corks, previously well dried, with a thick covering of some resinous substance, and cloth tied over all. But the cheapest and most effectual mode for larger articles, and indeed for botanical specimens generally, is to sew up each in cloth of any kind, with a wooden label attached to it, and numbered by branding, and to put the whole in a barrel, containing the solution of salt, and of such size that the specimens are loosely packed, and yet cannot easily change their position. He has frequently received specimens sent in this way, in a state of complete preservation, from Ceylon, the Isle of France, and the West Indies, although four or six months elapsed before they reached their destination.

Specimens which are to be preserved for demonstration should be immersed for a month or upwards in the saline solution before they are finally put up. The solution should then be changed, partly because it is usually somewhat coloured, but partly also because it is rendered too diluted in consequence of the juices of the vegetable passing out by *exosmosis*. The last solution should be filtered. It is often found difficult to confine the salt in the preparation jar. The most effectual method, where the mouth of the jar does not exceed two inches or two inches and a half in diameter, is to leave a space of half an inch or more at the top without fluid, to clean and dry the lip of the jar thoroughly, to drop melted sealing-wax on the upper surface of the lip, so as to form a uniform ring over it, to place over the mouth a watch-glass of such size as to cover the whole lip, or even to overhang it a little, to press this gently down with one finger, and to fuse the wax between the lip of the jar and the watch-glass, by moving a large-spirit lamp flame around the edge. After the whole ring of wax is thoroughly melted, the pressure must be kept up till the glass cools and the wax concretes. The glass never cracks in this operation, if carefully per-

formed; but occasionally the watch-glass cracks on cooling. Sometimes the watch-glass becomes displaced after a time; but this inconvenience is of little moment, as an adroit person may easily restore it in two minutes. Where the mouth of the jar is larger, the most effectual plan, and at the same time the easiest, is to tie one layer of sheet caoutchouc over it in the usual way for anatomical preparations. The caoutchouc should be stretched over the jar, but not strongly, by one, or still better by two persons, while another secures round the neck two or three folds of stout twine as a temporary ligature. A thinner twine is then drawn steadily and tightly round three or four times above the former, care being taken not to cut the caoutchouc.

Solution of salt is comparatively inapplicable, however, where the fruit is very pulpy,—in such fruits, for example, as *solanum lycopersicum*, or lemons and oranges; because the fruit shrivels by exosmosis of its fluids. Diluted pyroligneous acetic acid, diluted to the density of 1008, sometimes answers well in such circumstances; but after a few years the texture of the specimens becomes so pulpy and brittle, as not to admit of their being handled, and most colours are in no long time more or less altered. Spirit, which is most generally used, speedily renders all colours alike brown; but is probably better for delicate specimens which may be subjected to minute dissection.

PLANT CASE FOR GROWING PLANTS IN AN ISOLATED ATMOSPHERE.

This apparatus was originally invented by Mr Ward of Wellclose Square, London, and promises to be a useful and elegant portable conservatory to the lovers of plants residing in a crowded city.

In consequence of the vitiated atmosphere of large cities, even the most common plants and flowers wither and die away within a very short period. Drs Turner and Christison have ascertained, that it is not simply to the diffusion of smoke through the air, but to the presence of sulphurous acid gas generated in the combustion of coal, that the mischief is to be ascribed. When added to common air, even in the proportion of one ten-thousandth part, this gas was found sensibly to affect the leaves of growing plants in ten or twelve hours, and killed them in forty-eight hours or less. The effects of hydrochlori or muriatic acid gas were still more powerful, it being found that the tenth part of a cubic inch in 20,000 volumes of air manifested its action in a few hours, and entirely destroyed the plant in two days. Both these gases acted on the leaves, affecting more or less their colour, and withering and crisping their texture, so that a gentle touch caused their separation from the foot stalk, and both exerted this injurious operation when present in such minute proportions as to be wholly inappreciable by the animal senses. In this way vegetation is affected in the vicinity of some manufactories, around a circumference of fully one-third of a mile. After having suffered considerable injury from these acid gases, the plants, if removed in time, will recover, but with the loss of the foliage. Hence, in vegetation carried on in a vitiated atmosphere, the plants are rarely instantaneously destroyed, but only blighted for the season. In the following spring, vegetation again commences with its accustomed luxuriance; and as in many situations there is at that season, and throughout the summer, a diminution in the number of coal fires, there will be a proportionate decrease in the quantity of deleterious gases, and consequently less injury will be done to plants. In winter too, when the atmosphere is at its worst, deciduous plants are protected from its noxious operation, by a suspension of their vegetative powers while evergreens are, on the other hand, constantly exposed to its action. Accordingly, in London and other large towns, especially in manufacturing cities, vegetation is almost entirely destroyed. It was in order to protect his favourite flowers from the baneful influence of the city atmosphere, that Mr Ward contrived to inclose them in a limited atmosphere, and he found that plants continued to grow in this confined condition as vigorously and as freshly as in the free air of the country. The late Mr Ellis of Edinburgh thus describes a plant case constructed for him after the model of Mr Ward's:

It is composed of three parts; the stand, the box, and the glass roof or cover. The stand is one foot ten inches in height, the box eight and a half inches, and the cover one foot seven and a half inches, making the total height four feet two inches. The stand on which the box rests is made of mahogany, and supported on four legs furnished with movable castors. The box contains the soil, and is made of well seasoned mahogany, previously steeped for a fortnight in Kyan's preservative composition. It is a parallelogram, three feet long, and one and a half feet broad; its sides are one and a half inches thick, mitred and dove-tailed at the corners; the bottom of the box is of Honduras mahogany, one inch thick, and is formed of numerous small pieces, framed and flush pannelled, and so arranged as best to resist the yielding of the wood in consequence of the mass of moist earth which it has to bear. To give it greater strength, two cross or tie pieces stretch from side to side, and are dove-tailed into the sides. They are placed at equal distances from the two ends, and thus divide the box into three compartments, but as

they have large open spaces at the bottom and through their centres, they permit the moisture to percolate freely through the whole of the soil. The bottom being properly fitted, is fixed to the sides by brass screws, and other brass bands at the corners and bottom are fixed on with brass nails, no iron being used in any part. Along the upper edge of the box a groove is sunk to receive the lower edge of the glass roof, which rests securely in it. This groove is lined with lead, its inner lip is one-sixteenth of an inch lower than the outer, and at each end is a notch one-eighth of an inch only above the bottom of the groove, to allow the condensed moisture which trickles down the inside of the glass to flow back to the soil. Instead of lead, the lining of this groove should be of brass, which would prevent the galvanic action which arises from the contact of the two different metals. The glass cover which fits on to this box is framed of brass, into which common or plate glass is accurately fitted. It is furnished with a door on one side, also fitted close, but admitting of being easily opened when required. Along the top of the roof inside, two brass rods extend, from which small pots containing plants may be suspended. The whole of the frame work is well fitted and nicely put together, so as to preclude, as far as could well be done, all interchange between the air in the case and that in the room. The conservatory being thus prepared, its bottom was covered with broken potsherds to the depth of two inches, over which was spread an inch of very turfy loam. The remaining space in the box was filled with soil, composed of equal parts of peat and loam, with which a portion of rough white sand, amounting to about one-twentieth part, and free from iron, was mixed. After being planted, between three and four gallons of water were freely showered over the tops of the plants from a fine rosed watering pot. This was continued till the water ran freely from two holes made in the bottom of the box for that purpose. After draining for twenty-four hours, the holes were tightly fitted with corks, and the glass roof or cover was then put on. The plants were chiefly exotics, from various regions of the globe, among which were the dwarf palm, aloe, rhododendron, cycas, pitcher plant, gentian, primrose, lycopodinm stoliniferum, saraceniæ, &c. The case with its plants was then placed at the window allotted for it, which had a southern aspect, with the morning sun for several hours daily. During the sunny part of the day, the temperature within the case was several degrees higher than that in the room, while in the absence of sunshine, or when a fire was kept up, the temperature of the room was highest. At other times, when neither sun nor fire prevailed, the temperature within and without the case rose and fell simultaneously. At no period of the winter did the temperature of the room fall to the freezing point, nor, it is believed, rise in summer higher than to about 80°. No fresh water was given during the whole period of trial (twelve months,) nor was the door of the case opened, but to remove a dead leaf or plant that had damped off. Once only was the case taken off, in order to check the lycopodium stoliniferum, which had grown so luxuriantly as to shade and injure the other plants. At the end of the year, all the plants were, with a very few exceptions, in full vigour. The primroses had flowered, and the other plants had increased more or less in size. The tropical plants were as healthy and luxuriant as the others, though the mean temperature was comparatively low. From this interesting experiment, it appears that a confined atmosphere, by retaining the moisture of the soil and preventing evaporation, and consequent dissipation of moisture, precludes the necessity of a periodical supply of water. That from the still and undisturbed state of the air, and from the limited extent of the evaporation, less heat is necessary even for tropical plants, and that by the two vegetative functions somewhat analogous to respiration and digestion, an equilibrium of oxygen and carbonic acid gas is preserved in the atmosphere surrounding the growing plants. This circumstance will be better understood by a reference to the experiments of De Saussure, which were communicated to the public in 1797. This distinguished chemist found that when garden peas, which had attained to the height of between three inches and four inches, were placed in a recipient of atmospheric air, inverted in a saucer filled with water, and then set aside in a room well lighted, but which did not receive the direct rays of the sun, they grew well. At the end of ten days, the volume of air was considerably diminished, its purity greatly impaired, and it still retained $\frac{1}{180}$ of carbonic acid. Plants of méntha aquática effected similar changes in the air, whilst they continued to grow in the shade: whence it is inferred that plants, like animals, continually deteriorate the air, by converting its oxygen into carbonic acid gas, when they vegetate in the shade; a result confirmed by many experiments made by Mr Ellis, and given to the public in the years 1807 and 1811.

In prosecuting his experiments on vegetation under the direct influence of light, M. De Saussure was led, with others, to the conclusion, that, if the air which may have been deteriorated by the growth of plants in the shade be exposed for a short time to the sun's rays, it recovers its former purity. In his *Recherches Chimiques sur la Végétation*, published in 1804, he has established this position by numerous experiments on various plants, as méntha aquática, lýthrum salicària, pìnus sylvéstris, genevénsis, and cáctus

opúntia. These plants were confined in glass vessels of atmospheric air, and kept for eighteen or twenty hours in the shade, or in perfect darkness; but, early in the morning, the vessels were taken out and exposed for four or five hours to a bright sunshine; after such exposure, the air was examined, and was then found to have suffered no change whatever, either in purity or in volume.

By other experiments, the autnor next proceeds to show that, though the air, when thus exposed to light, had recovered its original composition, it must, during the experiments, have undergone successive changes of deterioration and renewal. If a substance, as moistened quicklime, which strongly attracts carbonic acid, were placed in the vessel with the growing plants, the volume of air was observed to diminish, even although the apparatus were placed in sunshine: the air, too, when analysed on the fifth or sixth day of the experiment, afforded only $\frac{16}{100}$, or had lost five per cent of oxygen gas; whilst similar plants, confined in another vessel, but without lime, produced no change, either in the purity or volume of their atmosphere. Now, the diminution of volume, in the experiment with lime, shows that there had been an attraction, and consequently a formation of carbonic acid gas; for the lime which produced the diminution, acted only on that gas. The experiment, it is added, shows farther, that the formation of carbonic acid gas is necessary to vegetation, even in sunshine, and that the reason why we do not perceive its production by the plants which vegetate without lime in common air, is, because they then decompose it in proportion as they form it with the surrounding oxygen.

This inference, respecting the simultaneous formation and decomposition of carbonic acid, derived from experiments made with common air, is supported by others, in which an artificial atmosphere, containing about seven per cent of carbonic acid was employed. Plants of the same species as those before mentioned were made use of, the same periods of alternate exposure in the shade and in sunshine were observed, and the same times allotted for the duration of the experiments. The total volume of air, at the end of the experiments, had undergone little variation, but its composition was greatly changed. The carbonic acid gas which was added to the atmosphere had more or less completely disappeared, and its place was supplied by an increase of oxygen gas, so as to raise its proportion from twenty-one to twenty-four or twenty-six per cent. In these experiments, therefore, not only was the carbonic acid naturally formed by the vegetation of the plants decomposed, but the excess of that gas which was added to the atmosphere underwent the same change; and the proportion of oxygen gas was consequently increased by five or six per cent beyond that which occurred in the experiments with common air.

From the results of these experiments, we learn that plants, like seeds, require the presence of oxygen gas in the atmosphere in which they grow, and like them, also, convert a portion of it into an equal volume of carbonic acid gas. This conversion is alike effected by their growth in the shade and sunshine. In the former case, however, the presence of this acid gas may be readily detected in the residual air by the usual tests; but, in the latter, it escapes detection, because it is then decomposed as soon as formed, by the joint agency of the plants and solar light. Under a bright sunshine, therefore, the two processes, by which carbonic acid is alternately formed and decomposed, go on simultaneously; and their necessary operation, in as far as regards the condition of the air, is that of counteracting each other. Hence, though both may be continually exercised in favourable circumstances, the effects of neither on the atmosphere can be ascertained by ordinary means; and, consequently, though in the experiments of De Saussure with common air, the production and decomposition of carbonic acid by plants in sunshine must have been continually going on, yet, in all the analyses which he made, the air was found unchanged, either in purity or in volume; in other words, the processes of formation and decomposition of this acid gas exactly counterbalanced each other.

Of the two processes which have been now described, each may be considered as in its nature and purpose quite distinct from the other; hence, their effects may be readily distinguished; neither do they necessarily interfere, when actually working together. The first, or deteriorating, process, in which oxygen gas is consumed, goes on at all times and in all circumstances, when vegetation is active. It requires always a suitable temperature in which to display itself; and when that temperature falls below a certain point, which is very variable in regard to different plants, the process is more or less completely suspended, again to be renewed when the temperature shall again return. This conversion of oxygen into carbonic acid is as necessary to the evolution of the seed as to the growth of the plant, and is all that is required for germination; but the plant requires something more, for, if light be excluded, vegetation proceeds imperfectly, and the plant does not then acquire its proper colour, and other active properties which it ought to have. The chief organs by which the consumption of oxygen gas is effected are the leaves, and its purpose, in great part at least, seems to be that of producing some necessary change in the sap during its transmission through those organs, on its way from the vessels of the wood to those of the

inner bark, whereby it may be rendered fit for the purposes of nutrition and growth. In its nature and object, therefore, as well as in the specific change which it produces in the air, this process closely resembles the function of respiration in animals, and may thus with propriety be deemed a physiological process.

The second, or purifying, process, in which oxyen gas is evolved, differs, in all respects, from that which has just been described. It is, in a great measure, independent of temperature; at least it proceeds in temperatures too low to support vegetation, provided light be present, an agent not required for germination, nor essential to vegetable development. The organs by which this process acts on the air are, as before, the leaves; not, however, by changing the qualities of the sap in the vessels of those organs, but by producing changes in the chromule, or colourable matter, in their cells, to which it imparts colour and other active properties. In doing this, it does not convert the oxygen gas of the air into carbonic acid; but, by decomposing that acid gas, restores to the air the identical portion of oxygen of which the former process had deprived it. The former process, carried on by the agency of the oxygen gas of the air, was essential to living action, and affected the well-being of the whole plant; that exercised by the agency of light is not necessary to life; is local, not general in its operation; and is capable of proceeding in circumstances and under conditions incompatible with living action. By withdrawing the air altogether, or depriving it of oxygen gas, vegetation soon ceases through the whole plant; but the exclusion of light from any part of the plant affects that part only; and even the total exclusion of that agent only deprives the plant of certain properties necessary to its perfection, but not essential to its life. These differences in the processes by which oxygen gas is alternately consumed and evolved, during the vegetation of plants in sunshine, are so manifest, both in their nature and effects, as to justify the ascription of a name to the latter process distinct from that given to the former.

Applying these views to the subject under consideration, we see no difficulty in comprehending how the same identical volume of air in the plant cases of Mr. Ward should, for so long a period, serve the purposes of vegetation, without becoming foul from within, or receiving or requiring renewal from without. The experiments of De Saussure furnish, as we have seen, examples of a similar kind; and supply, at the same time, the desired explanation. The daily depravation and subsequent purification which the air underwent in the glass vessels of that eminent chemist, must be equally accomplished, under similar circumstances, in the glass cases of Mr. Ward, that is, when their plants are similarly exposed to vegetate alternately in sunshine and in shade. And as the former found the air to continue for many days together unchanged, either in purity or in volume, when so treated; so must the air, in the plant cases of the latter, preserve, under similar treatment, its original composition and purity; not, however, by continuing always the same, but by simultaneously undergoing opposite changes in sunshine, or successive changes by alternate exposure to light and shade, which mutually counterbalance each other. Thus the deterioration of the air, occasioned by vegetable growth, is counteracted by another process, necessary to the perfection of the plant; and, amidst the vicissitudes of perpetual change, the atmosphere of these cases is maintained in a state of nearly uniform composition and purity. In this way, the same air by changes of composition, like the same water by changes in its state or condition, may be made to serve over and over again the purposes of vegetation.

There is one circumstance of difference in the experiments of De Saussure, as compared with those of Mr. Ward, which it may be proper to notice. In the experiments of the former no soil was used, but only a thin stratum of water, in which the roots of the plants were immersed, covered the surface of the mercury, over which the vessels were inverted. In the cases of Mr. Ward, the plants were set in earth. Now, vegetable soil is known to deteriorate the air, by forming carbonic acid with its oxygen, in the same manner as plants do; but the acid gas, which may thus be produced, was found by De Saussure to be decomposed by the joint agency of the plants and light, like that produced by ordinary vegetation; and, consequently, the air suffered no permanent injury. Indeed, an excess of carbonic acid, not exceeding one-twelfth of the atmosphere in which plants were confined, accelerated their vegetation in sunshine, by increasing the proportion of oxygen; whilst the smallest doses of this gas proved injurious to that process in the shade.

The foregoing facts demonstrate the power of light to decompose carbonic acid gas in plants. This decomposition, however, can be effected only by the concurring agency of the light and the plant; and, whilst the acid gas is decomposed, the plant itself acquires a tint of green; so that the evolution of oxygen gas by the plant, and the formation of its green colour, always proceed together. Now, as the chromule, which imparts colour to the leaf, is lodged in the cells of the parenchyme, it is in those cells that we must suppose the decomposition of the acid gas to be effected, and from them also the oxygen gas must proceed. The mode in which this coloration is probably accomplished may receive illustration from the facts which follow. The

"colourable principle," or chromogen of Dr. Hope, is readily extracted by water, and the colourless infusion which is thus formed becomes red on the addition of an acid, and green on the addition of an alkali. If a neutral salt be dissolved in this infusion it still remains colourless; but, if this salt be decomposed by electrical agency, then the acid and alkaline ingredients, being separated, at once produce their red and green colours. Now, if we suppose the carbonic acid gas, which enters the parenchyme of the leaves, to be attracted by, and to combine with, the alkaline matter which is so abundant in those organs, it may there form a neutral salt, and whilst this neutral state continues, the leaf will remain colourless; but if the chemical rays of light, acting like electricity in the example before given, decompose this carbonate, and cause the expulsion of its acid ingredient, then the alkali, becoming predominant, will produce its usual effect on the xanthogen of the leaf, and its chromule will in consequence be rendered green. In order to maintain this green colour in the leaf, the action of light on its saline ingredients must be regarded as in continual operation; and hence its exclusion, by suspending that action, is followed by a gradual loss of colour; and, as the carbonic acid gas is no longer decomposed, the leaf at the same time ceases to afford oxygen gas. The colouration of the leaf, therefore, is not immediately due to the evolution of oxygen, nor even to the subtraction of carbonic acid, but to the predominance of alkaline matter which that subtraction of acid occasions; consequently, the verdure succeeds to the decomposition of the acid, the evidence of which is afforded by the expulsion of oxygen gas. Hence, to speak correctly, we cannot so properly say that the green leaf affords oxygen, as that it becomes green when that gas is expelled; and thus it is, that the decomposition of carbonic acid by the agency of light gives rise, at once, to the evolution of oxygen gas, and the formation of the green colour in plants.

The invention of Mr Ward is practicable on the simplest scale, and may be adopted, at a trifling expense, by any person. A bell glass or crystal bottle, with the bottom cut away, and fitted over a wooden box, or placed over a common flower pot, will answer perfectly well. And thus delicate plants may be preserved in perfection. Succulent plants, or those that delight in a moist atmosphere, will succeed best, while those plants which flourish in a dry soil and air are apt to deteriorate. The growth of minute fungi, too, from the close damp atmosphere, also affects the health of the plants. Boxes of common wood, with glass above, have been constructed, for the transportation of living plants from distant countries. This plan, therefore, may be practised to any extent, or adapted to any scale of expense, which the individual may find it either convenient or desirable to employ. When once fitted up, the apparatus, be it either small or large, requires scarcely any farther care or attendance. No fresh watering or airing is at any time required; nor is any inconvenience experienced from dust and litter, which often render the ordinary mode of keeping plants in well-furnished apartments objectionable and troublesome. Farther, as the plants in this apparatus are shut off from all communication with the external air, no apprehension of their injuring the atmosphere, even of close rooms, can be reasonably entertained. The only condition, in regard to attendance, that claims observance, is an occasional exposure to light, perhaps for a short period only on days of sunshine, and for a longer one when the light is more feeble. These are advantages which render the method easily practicable by persons of every class; and will enable those who are condemned to live in a smoky atmosphere to refresh their sight with specimens of healthy vegetation within their own abodes, although the district around them should exhibit only the sickly and stunted forms of vegetable existence.

The celebrated Franklin, who looked at every thing with the eye of a philosopher, and sought to turn to some useful purpose every observation which he made, in recording the reviviscence of some common flies which had made a voyage from Virginia to England in a bottle of Madeira wine, goes on to state that a plant with its flowers fades and dies if exposed to the air without having its roots plunged in a humid soil, from which it may draw moisture to supply the waste of that which it exhales, and which is continually carried off by the air. Perhaps, he adds, if it were buried in quicksilver it might preserve for a considerable time its vegetable life; and, if this be the case, it might prove a commodious method of transporting from distant countries those delicate plants which are unable to sustain the inclemency of the weather at sea.

The ingenious suggestion of the American philosopher has been happily realised in practice by Mr Ward, in a way much more simple and efficient than that which Franklin proposed. By its means, the rarest and most delicate plants have been transported to and from the most distant countries, with little or no trouble in regard to attendance, and scarcely any risk of suffering from the inclemency of the weather at sea. He has thereby conferred on the botanist and horticulturist benefits which no researches of travellers, however successful, nor expenditure of money, however great, could have enabled them otherwise to procure. Instead of simple descriptions, or dried specimens, or fine pictures of foreign plants, they can now fix their eyes on living specimens retaining their native freshness

and beauty, and possessing all their natural and characteristic properties. Already have exchanges of plants between distant countries been carried on to a great extent; and the public conservatories, as well as those of private individuals, been enriched with specimens of many rare plants, which could scarcely have reached them by any other means. Thus, under the modified conditions with regard to climate, and the renovating processes in relation to water and air which we have attempted to illustrate, the botanist and horticulturist may be said to have entered on new and unexplored fields of vegetable research, and to have acquired the means of transporting to their own soil the varied and most delicate plants of every region of the earth.

DIRECTIONS FOR PRESERVING SEEDS, ROOTS, BULBS, &c.

Seeds of all kinds should be gathered in dry weather, and kept in dry airy situations.

Various plans have been proposed for preserving and sending home seeds from foreign countries, especially from moist and hot climates, such as packing them in sugar, salt, tallow, cotton, saw-dust, sand, clay, or paper. The first object is to have the seeds perfectly dried. In very moist climates, the larger seeds may be dried by exposing them in Leslie's vacuum along with sulphuric acid, when they will become quite dry in a week, and smaller seeds in two days. These seeds thus dried, may afterwards be preserved for a great length of time, by putting them in small parcels in common gray paper and airing them occasionally. Very small seeds, berries, and oleaginous seeds may be kept in sugar, or among currants or raisins. Seeds may also be preserved and sent to a distance, if after full maturation and perfect drying, they are enveloped in a large ball of loam and then baked in the sun, or they may be enveloped in charcoal or any other dry substance.

Roots, cuttings, grafts, and perennial plants in general, may be kept in earth or moss moderately moist and shaded from the sun. When they are to be sent to a distance, the roots or root ends are to be stuck into balls of clay or loam, wrapped round with moist moss, or they may be stuck into potatoes or apples. In this way, orange trees are sent from Italy to any part of Europe and North America in perfect preservation; and cuttings will thus live for eight months or upwards. Packing and transporting roots of plants, or entire plants in a dormant state, for short journeys, is managed by the enveloping them in twisted straw covered with mats. If for a longer journey, the roots are covered with moist mould and moss, but very moist moss is not desirable, as it occasions mouldiness, and rots off the bark of the roots when it begins to dry.

Air plants, or parasitical orchideæ, may be transported safely to any distance by being packed loosely in moss, and put into boxes so constructed that the plants may be exposed to a free admission of air, but protected from the sea-water.

Bulbs are best preserved and transported if packed in common brown paper or canvass bags, having been previously freed of all their superfluous moisture. Dry sand is a good medium for placing those bulbs in, which have not previously been dried in the sun. Minute bulbs, such as those of ixias, gladiolas, &c., only require to be folded in separate parcels without any previous preparation. Terrestrial orchideæ should be transported when in flower, and not when their roots are in a state of rest.

Woody seeds or capsules, or any of those seeds, the juices of which are liable to become rancid soon after gathering, should be buried in common mould in pots, at the commencement of the voyage, and they will thus vegetate before its termination. Thus, too, camellia seeds are best transported by planting them in pots on leaving China, when they will have become seedling plants on reaching this country. Acorns, and walnuts, and palms, may also be treated in this manner.

Ripe fruits, such as apples and pears, if put into stone pipkins, closely covered up, and placed in cellars where the temperature never falls below 32°, nor rises above 42°, will frequently keep in good preservation for twelve months.

All esculent roots, such as potatoes, turnips,

carrots, and parsnips, which it is desired to preserve through the winter, are put into pits in a dry soil and covered over with three or four feet of mould. In this way also, apples and grain in some countries are covered up in a dry sandy soil, and are found to keep for a year. Roots, brocoli, celery, and other vegetables, may also be preserved in an ice house during the winter, by placing them in baskets with a little straw between them and the ice. Before using them they should be slowly thawed in cold water.

Some fruits are best preserved by pulling them off the tree before they are quite ripe. This is the case with oranges imported into this country, but in this way the flavour of the fruit is greatly lost.

Grapes and other fruits have been preserved ever winter in mild climates, by allowing them to hang on the trees in their ripe state.

VICTORIA REGIA, THE ROYAL WATER-LILY.

The Victoria Regia, or Great Water-Lily, has been with equal taste and propriety dedicated to the Queen. Sir Robert Schomburgk found the plant in British Guiana, when travelling for the Royal Geographical Society of London, and his narrative of the discovery is lively and interesting:—"It was on the 1st of January, 1837, while contending with the difficulties that nature interposed in different forms, to stem our progress up the river Berbice (lat. 4° 30′ N., lon. 52° W.), that we arrived at a part where the river expanded and formed a currentless basin. Some object on the southern extremity of this basin attracted my attention, and I was unable to form an idea what it could be; but, animating the crew to increase the rate of their paddling, we soon came opposite the object which had raised my curiosity, and, behold, a vegetable wonder! All calamities were forgotten; I was a botanist, and felt myself rewarded! There were gigantic leaves, five to six feet across, flat, with a broad rim, light green above and vivid crimson below, floating upon the water; while, in character with the wonderful foliage, I saw luxuriant flowers, each consisting of numerous petals, passing in alternate tints from pure white to rose and pink. The smooth water was covered with the blossoms; and as I rowed from one to the other, I always found something new to admire. The flower-stalk is an inch thick near the calyx, and studded with elastic prickles, about three-quarters of an inch long. When expanded, the four-leaved calyx measures a foot in diameter, but is concealed by the expansion of the hundred-petalled corolla. This beautiful flower, when it first unfolds, is white, with a pink centre; the colours spread as the bloom increases in age; and, at a day old, the whole is rose-coloured. As if to add to the charm of this noble water-lily, it diffuses a sweet scent."

The plant was first flowered in this country at Chatsworth, by Mr. (now Sir Joseph) Paxton.

Victoria Regia, The Royal Water-Lily.

APPENDIX.

The following pages contain descriptions of the figures in those new plates added to this edition, in so far as not already described in the previous portion of the work. By a reference to the Index, or List of Plates, the descriptions of the remaining figures will readily be found:—

PLATE XIII.

Tree Ferns.

Fig. 1.—*Alsophylla excelsa,* one of the most magnificent of the tree ferns. It is a native of Norfolk Island, where it abounds in moist places, and attains the height of from fifty to eighty feet, with a trunk scarcely a foot in diameter, and crowned at the summit with numerous long graceful fronds, which give it somewhat the appearance of a palm. The fronds are twice pinnate, and from seven to twelve feet long.

Fig. 2.—*Dicksonia arborescens,* a native of St. Helena, growing near the summit of Diana's Peak. It is remarkable that this species has not yet been detected in any other part of the world. Its stem attains the height of fifteen or more feet, bearing at its summit a tuft of dark rusty-green thick or coriaceous fronds, which are from ten to twelve feet long, and twice, or sometimes thrice pinnated.

Fig. 3.—*Cyathea elegans* (variety of *arborea*), a native of Jamaica, and grows to about twenty-five feet high, with an erect stem, about six inches in diameter, and covered with the oblong cicatrices or scars left by the fallen fronds, which give it a tesselated appearance. The numerous glabrous bipinnate lanceolate fronds are produced from the top of the stem, and are about ten feet long, with a spiny stipes, three feet in length, thickly covered upon the upper surface with light, fawn-coloured, deciduous scales. The pinnæ are two feet long.

Fig. 4.—*Cyathea arborea,* a very fine tree fern, growing in most of the West Indian islands in woody shaded places. It has a hard stem or caudex, which attains the height of twenty feet or more, and is covered with the spiny bases of the stipes of old fronds, intermixed with black wiry roots, and furnished at the summit with numerous long, lanceolate, bipinnate, stiff, coriaceous fronds, which are ten or more feet in length, and of a dull green colour. The stipes of the fronds are densely armed with short, stiff, blackish spines, and the rachis is clothed with rusty-brown hairs, mixed with a few chaff-like scales. Both the stipes and rachis are of a dark brownish-black colour.

Fig. 5.—*Hemitelia speciosa,* a native of Brazil, Caraccas, &c., first discovered at Caripé by Humboldt, who says that it attains the height of from thirty-two to thirty-seven feet. It has numerous broad lanceolate, pinnate, glabrous fronds, which are from five to ten feet long, and of a deep green colour.

Fig. 6.—*Drynaria coronans* is a native of the eastern parts of India, growing principally on trees, with a thick, scaly, creeping rhizome, from which arise numerous deeply pinnatifid fronds, which are about four feet long and one foot wide, attenuated towards and cordate at the base. They are arranged in a circular manner, having somewhat the appearance of a large crown. Hence the specific name *coronans,* which is applied to it.

Fig. 7.—*Platycerium grande,* a remarkable epiphytal fern, native of New Holland and some of the Malayan islands, where it grows on trees to a large size. It has two kinds of fronds, barren and fertile, both proceeding from the same axis of growth. The barren fronds are sessile, ascending, round, or somewhat elongated, and divided towards the top into numerous broad lobes, or segments, which are blunt at the apex. Each succeeding barren frond grows completely over the old ones, which latter in time lose their vitality, but still remain attached to the axis of growth, and, by the successive development of new fronds over them, ultimately form a dense, round, spongy mass, with the growing barren fronds at the outside. In very old plants these masses are upwards of three feet in diameter, and sometimes become so heavy, from the quantity of water, &c., which collects in them, that they are detached from the tree upon which they were growing, and fall to the ground. The fertile fronds are pendulous from the axis of growth, and have a short footstalk or stipes. They are narrow at the base, but gradually get wider, until, at about a foot from the stipes, they divide into two parts, or *fork,* each part being again repeatedly forked, and often attain the length of six feet. Both the barren and fertile fronds are of a bluish green colour, and are covered with white stellate pubescence.

Fig. 8.—*Neottopteris vulgaris* (Bird's-nest Fern). This curious fern is a native of New Holland, India, the Malayan and Pacific islands, Mauritius, and numerous other places, where it grows on moist trunks of trees. It is commonly known by the name of "The Bird's-nest Fern," from the circumstance of the fronds being spreading, arrayed in a circular form, and having somewhat the appearance of a gigantic bird's nest. The generic name, Neottopteris, is derived from *neottia,* a bird's nest, and *pteris,* a fern. The roots of this plant are congregated into a dense mass, or tuft, from which arise numerous simple, lanceolate, acute, rather stiff, coriaceous, spreading fronds, from two to four feet long, and four to six inches wide in the middle, but somewhat attenuated towards both ends. They are smooth, of a shining green colour, and have very short footstalks, or stipes, with a dark green angular rachis, or midrib.

Fig. 9.—*Asplenium lucidum,* a spleenwort from New Zealand, with shining, bright green, pinnate

fronds, about two feet long and one foot broad, having a round stipes, or footstalk, with a channel or groove along the upper side. The pinnæ are nearly opposite, shortly petiolate, and oblong acuminate, with a serrated margin and simply forked veins.

PLATE XIV.

Cacti.

Fig. 1.—*Opuntia Brasiliensis*, a native of Brazil, belongs to a group of Cacti to which the name of "Prickly pear" has been given, from their fruit being pear-shaped, and having small tufts of short spines upon their surface. This species has a straight, round, woody stem, which attains to the height of thirty or forty feet and upwards, becoming gradually attenuated towards the top, and armed with numerous fascicles of long spines, which are very strong, sharp, and ash-coloured. It is furnished with a number of almost horizontal branches, which gradually become shorter towards the top, giving it a pyramidal appearance. The flowers are produced in great abundance, chiefly from the prominent parts of the margins of joints. When fully expanded, they are about an inch and a half in diameter, and of a bright lemon colour. The fruit is oval or pear-shaped, about an inch and a half in diameter, and slightly hollow at the apex. Its skin is thin, smooth, of a shining pale yellow colour. It is almost impossible to handle the fruit without getting the skin full of bristles, which break off and leave a fragment behind. Owing to the bristles with which the skin is armed, it is seldom used as a dessert fruit; although the fruit of *Opuntia vulgaris*, a closely allied species, which is cultivated in the south of Europe, is much esteemed as a dessert fruit, and large quantities of it are consumed, especially in some parts of Spain.

Fig. 2.—*Cereus senilis*, the "Old man Cactus," is a native of the hottest parts of Mexico; it grows to about twenty or twenty-five feet high, and nine or ten inches in diameter at the broadest part. Its stem contains an extraordinary quantity of oxalate of lime in small sand-like grains, which renders it very heavy and brittle; portions of the dried tissue have been analyzed and found to contain from sixty to eighty per cent. of this substance. The surface of the stem is of a grayish green colour, and is divided into thirty or forty narrow furrows, which are about half an inch deep, and have very acute sinuses; the ridges are obtuse, rounded, and furnished with elongated areoles, seated on small tubercles, from which proceed three or four long white spines, surrounded by a thick mass of very long, wiry, white or gray hair, from which circumstance the plant is commonly called the "Old man Cactus." The flowers of this plant have never, to our knowledge, been produced in Europe.

Figs. 3 and 10.—*Opuntia cochinillifera* (the Cochineal-insect Cactus) is a native of Mexico, but it is cultivated in the West Indian islands and other places. (See p. 365.)

Two kinds of cochineal are distinguished in commerce. One sort is called *Grana fina* by the Spaniards, the other *Grana sylvestre*. The colouring matter of the first sort is of a finer quality and in greater abundance than in the latter; and the substance which envelopes the insect is pulverulent or powdery in the former, whilst in the latter it is flocculent or cottony; but it has not yet been determined whether they are different species of *Coccus*, or whether the differences do not depend upon the species of Opuntia used, or the method of culture adopted.

Fig. 4.—*Echinocactus Stainesii*, a native of Mexico, growing abundantly at San Luis Potosi. The stem is somewhat elliptical, and about five or six feet high, and one to two feet in diameter; it is slightly woolly at the top, of a deep green colour, and has from seventeen to twenty furrows. The flowers are produced on the top of the plant.

Fig. 5.—*Cereus cœrulescens* is a native of Brazil, and has an angular glaucous blue coloured stem, rising perpendicularly to the height of fifteen or twenty feet, with a diameter of three or four inches in the broadest part, slightly attenuated towards the base. It is divided into eight or ten furrows, with a corresponding number of obtuse, wavy ridges. The flowers of this plant grow from one of the areoles towards the top of the plant, and are very nearly as large and beautiful as those of *Cereus grandiflorus*, the "Night-flowering Cereus."

Fig. 6.—*Echinocactus visnaga* grows to a large size; two gigantic specimens of it were sent to the Royal Botanic Garden at Kew some years ago, from San Luis Potosi, but both have since died; one of them weighed 713 pounds, and measured four feet and a half in height, and about two feet nine inches in diameter; the other was still larger, weighing one ton, and being nine feet in height, with a diameter of more than three feet; but these are said to have been small plants in comparison with others growing in their native country. In shape this species is somewhat elliptical, and has forty or fifty deep, narrow furrows, with the same number of wavy, sharp-edged ridges; the furrows are of a glaucous green colour, becoming lighter towards the top of the ridges, and the centre of its summit is covered with a dense mass of a short, tawny, wool-like substance. The flowers are produced singly, from amongst the dense woolly substance at the top of the plant; they have numerous serrated petals of an oblong or spathulate form, and a shining yellow colour.

The specific name of *visnaga* has been given to this plant, in allusion to the use to which the Mexicans apply the spines, viz., for making toothpicks, *visnaga* or *viznaga* signifying in Spanish *toothpick*. It has been calculated that the number of spines on the largest plant of this species sent to Kew Gardens, could not have been less than 51,000!

Fig. 7.—*Cereus hexagonus*, a native of Surinam and other hot parts of South America, where it attains the height of forty feet and upwards, seldom having any branches; its stem has usually six angles, or sometimes more, with very wide furrows. The flowers are produced from the angles of the stem near the top of the plant, and have a tube about six inches long, with imbricated greenish sepals, and petals which are reddish outside and white within; the

stamens are numerous, and slightly tinged with green. Its fruit is a round or oval berry of a dark purple colour.

Fig. 8.—*Cereus Peruvianus*, var. *monstrosus.* This curious monstrous variety of *Cereus Peruvianus* is a native of Peru and other hot parts of South America; it grows to the height of ten or twenty feet, with an erect, fleshy, branched, and irregularly furrowed stem. The flowers are like those of *Cereus Peruvianus*, but larger and more spreading.

Fig. 9.—*Cereus grandiflorus*, the "Night-flowering Cereus." (See p. 364.)

Fig. 11.—*Echinocactus oxygonus.*—This species is a native of South Brazil; it has a fleshy, round, or oval stem, about six inches or a foot in diameter. The flowers spring from the areoles of some of the upper fascicles of spines; the tube of the calyx is very long, narrow at the base, but widening out towards the apex, and becoming trumpet-shaped; its segments are narrow, sharp-pointed, and of a deep rose colour; the petals are white, tinged with rose colour at the tips, and their segments are much broader than those of the calyx.

Fig. 12.—*Echinocactus myriostigma* is a native of San Luis Potosi. It differs from all the other species of the genus, in not being furnished with spines. In its native country it sometimes grows to the height of fifteen or sixteen inches, but the specimens in European gardens are only about five or six inches high, rather oblong, and depressed at the top. The flowers are produced from areoles at the top of the plant; they are about two inches in diameter.

Fig. 13.—*Echinocactus helophorus*, a native of the south of Mexico, about San Luis Potosi; its stem is nearly spherical, somewhat depressed at the top, about eighteen inches in diameter, and of a light green colour. The summit of the plant is covered in the centre with a light brown wool-like substance, from amongst which the shining yellow flowers are produced.

Fig. 14.—*Melocactus communis.* This plant is a native of the West Indian Islands, growing in dry, barren places near the sea, and upon porous rocks, into which its roots penetrate, but from which it seems almost impossible that they can derive any nourishment; indeed, it has been asserted by some persons that this and other species of cacti derive the greater part of their nourishment from the atmosphere; but it has been proved, by careful analysis, that this opinion is erroneous. Its stem attains the height of from one to two feet, is either round or somewhat ovate, and has twelve to eighteen furrows; the ridges are armed with spines, arranged in stellate fascicles, or bundles, at certain regular distances from each other; each bundle contains from five to ten pale or dusky-brown coloured spines of unequal size, the lower ones being largest. Upon the top of the stem there is a cylindrical cap, or crown, about one-third the diameter of the stem, and from this the flowers are produced; this crown, or top, is generally known by the name of "Turk's cap" or "Turk's head;" hence the vernacular name of the plant is "Turk's cap Cactus." In some places they are called "Englishmen's heads" and "Popes' heads." It is composed of numerous reddish-brown coloured spines, imbedded in a white wool-like substance; the flowers are imbedded in this mass of spines and wool, and protrude only a short distance beyond the spines; they are very small, tubular, and of a red colour; the calyx and corolla are combined into a single perianth, which is divided into many segments; the anthers are sessile, and inserted into the throat of the perianth. Its fruit is a small, ovate, oblong, wedge-shaped berry, which, like the flower, is also imbedded amongst the spines and wool, constituting the "Turk's cap;" but when perfectly ripe they are gradually ejected from it; the seeds are numerous, small, black, and shining.

PLATE XV.

FRUIT AND ORNAMENTAL TREES.

Fig. 2.—*Chamærops excelsa*, the hemp palm, a native of Nepaul. Fig. 3.—*Cupressus funebris*, funeral cypress. Mr. Fortune, in his work on the *Tea Countries of China, including Sunglo and the Bohea Hills*, describes this weeping cypress as the most beautiful tree found in that district, growing to the height of about sixty feet, with a stem as straight as the Norfolk Island pine, and weeping branches like the willow of St. Helena. Its branches grow at first at right angles to the main stem, then describe a graceful curve upwards, and bend again at their points. From these main branches others, long and slender, hang down perpendicularly, and give the whole tree a weeping and graceful form. It reminded the traveller of some of the large and gorgeous chandeliers seen in theatres and public halls in Europe.—For other figures, see Index or List of Plates.

PLATE XVI.

PALMS, PINES, &c.

Fig. 1.—*Araucaria imbricata*, the Chili pine, which was brought to this country in 1792, by Mr. Menzies, the surgeon in Captain Vancouver's voyage. The figure in the plate is a portrait of a fine specimen of this tree in the Edinburgh Botanic Garden. The plant grows naturally in dense forests, similar to our woods of Scotch fir. The Chilians eat the seeds of the plant as the Italians do the seeds of the stone pine. The Araucaria is becoming a favourite ornamental plant in all parts of the United Kingdom, being sufficiently hardy to withstand our winters. Fig. 7.—*Cycas revoluta;* its stem, like that of *C. circinalis*, p. 261, produces sago. *C. revoluta* is a native of Japan. The *Cycas* is allied to the conifers.—For other figures, see Index or List of Plates.

PLATE XVII.

PINE TREES.

Fig. 2.—*Pinus Sabiniana*, or Sabine's pine, a native of California, and along the western flanks of the Cordilleras of New Albion, at an altitude reaching to within 1600 feet of the line of perpetual snow, where it was first discovered by the late lamented Mr. David Douglas, in 1826, and again in 1831, when he sent ripe seeds of it home to the London Horticultural Society, from which plants were abundantly raised and liberally

distributed over the country. Mr. Douglas described it as a magnificent tree, attaining the height of 140 feet, and four feet in diameter. Its prickly cones are large; so are the seeds, which are eaten by the natives of those countries, and are pleasant to the taste. The tree is perfectly hardy, and well endures our severest winters. The wood is whitish, and rather soft, especially in situations where its growth is rapid. Fig. 4. —*Pinus pinea*, the stone-pine, p. 464. This is the pine of Claude Lorraine's Italian landscapes. Fig. 5. —*Cedrus deodara*, the deodar, from the mountains of northern India, equal, if not superior in beauty to the cedar of Lebanon, of which some eminent botanists now consider it to be a variety. The wood is compact and durable. The gates of the celebrated temple of Somnauth are constructed of deodar; as those of Solomon's temple were, and those of St. Peter's at Rome are, of the cedar of Lebanon. Fig. 6.—*Abies excelsa* or *Clanbrassiliana*, Lord Clanbrassil's spruce-fir, very generally considered only as a variety, although by some ranked as a species, which certainly its appearance and growth would warrant as very different from any other spruce, being a low compact bush, of from three to four feet high, with short, numerous branches, closely covered with leaves, which are seldom more than one-fourth of an inch long. Introduced to Britain by Lord Clanbrassil; the date and locality uncertain, but supposed to be from the Levant. Fig. 7.—*Pinus Coulteri*, or Dr. Coulter's pine, a native of the western coast of North America, extending from 40° to 43° north; also on a range of low hills from the Rocky Mountains towards the sea at Cape Orford, of Vancouver, where it was discovered by the late distinguished botanical collector, Mr. David Douglas, in 1826, when he sent home seeds to the London Horticultural Society, where it was raised and distributed to the various collections. It was met with more recently by Dr. Coulter on the mountains of St. Lucia, at an elevation of nearly 4000 feet above the level of the sea. That gentleman likewise sent home fresh seeds of it to various gardens, where it has been raised. It is perfectly hardy, and is said to attain a height of 100 feet, with a circumference of 12 feet. From its rapid growth, the wood is not expected to be valuable; but the tree is highly ornamental, either in the pinetum or singly on the lawn or park.—For other figures, see Index or List of Plates.

PLATE XVIII.

A BRAZILIAN FOREST.

Meyen and Von Martius state that a characteristic feature in Brazilian forests is the variety and profusion of climbing plants. By the commingling of their branches, they bind themselves closely to the wood of the tree which supports them. In this process the strength of the original root of the parasite becomes weakened, and as a counterpoise, the stem sends down air-roots, and thus this tenacious and vigorous race continually acquire fresh strength and freedom. "In proportion (says Meyen) to the majestic beauty of a primeval forest, is its fearful grandeur when in conflict with the wild elements. To be in such a forest during a violent hurricane, is described as more fearful than to struggle with the raging waves in the open sea. When the boisterous wind catches hold of the tops of the gigantic trees of these natural forests, and shakes the branches and trunks against each other, the air is filled with a fearful rushing, thundering, rattling, and crashing. Even the strong lianas (climbing plants) are torn asunder, and the broken branches and stems fall to the ground. The rain, at first warded off by the thick canopy of foliage, now falls in torrents; almost all the inhabitants of the forest betray their fear by mournful howling and crying; the apes, the large bats, and the whole host of birds call loudly together, and the croaking of the tree-frogs and others of this family, sometimes like the sound of a drum, discloses the misery of the moment."

The forms of the palm, the musa, the arborescent grasses, fig-trees, orchids, and other parasites and climbing plants, determine the character of the vegetation of this as of other portions of the equatorial zone.

Dr. Von Martius describes the bush-ropes of the Brazilian forests on the Organ Mountains, as clinging round the trees, and hanging down from them in graceful festoons. These ropes yield a milky or yellowish juice when wounded, and probably belong to the dogbanes or asclepiads. The twining plants, decorated with beautiful green leaves, consist of species of banisteria, smilax, serjania, and bignonia, voluptuously interlaced and entangled.

PLATES XIX.—XXI.

MEDICINAL PLANTS.

For page of description, see Index or List of Plates.

PLATE XXII.

MEDICINAL PLANTS.

IPECACUAN (*Cephælis ipecacuanha*), a plant of the cinchona tribe, with an annulated root, which is the ipecacuan of the pharmacopœias. It is emetic and diaphoretic.—For other figures, see Index or List of Plates.

PLATES XXIII., XXIV.

SPICE PLANTS.

For page of description, see Index or List of Plates.

PLATES XXV., XXVI.

GUM PLANTS.

GUM OLIBANUM, the product of *Boswellia serrata*, a native of India, called also *Libanus thurifera*. Olibanum is chiefly used as a grateful incense; but it possesses also stimulant, astringent, and diaphoretic properties. Arabian frankincense has also been said to be the produce of the same tree, but this is uncertain. GUTTA PERCHA is the produce of *Isonandra gutta*, a native of Singapore, Borneo, and other Malay islands. It is a large tree, with spongy wood, and leaves of a leathery texture, green on the upper, and orange-yellow on the lower surface. The Malays destroy the trees in order to get at the juice, instead of collecting it from incisions made in the growing

tree, as in the case of the plants producing caoutchouc. A single tree yields about 20 or 30 lbs. of gutta percha. The substance was made known only in 1845; its uses are already innumerable. The annual imports into Great Britain are about 1000 tons a-year.—For other figures, see Index or List of Plates.

PLATES XXVII.—XXX.

PLANTS USED AS FOOD.

For page of description, see Index or List of Plates.

PLATES XXXI., XXXII.

PLANTS USED IN DYEING.

For page of description, see Index or List of Plates.

PLATES XXXIII., XXXIV.

PLANTS USED IN CLOTHING AND CORDAGE.

GOMMUTI-PALM (*Arenga saccharifera*). The substance named gommuti, used for cordage, canvas, and other economical purposes, is a fibre produced by the splitting or decay of the leaf-stalks of this palm. The fibres are stiff and deficient in elasticity, preventing it from being much in request for cordage in this country, where only small quantities of them are received. PIASSAVA-PALM (*Attalea funifera*), piassava, piaçaba, monkey-grass, or para-grass, is a fibre produced by this palm in a similar manner to the gommuti, namely, by the separation of the leaf-stalks or petioles, which are of great length, often nearly twenty feet. The fibres are about the thickness of a rush, round, and not very flexible, so that they are neither woven nor spun in this country, but are much used in making brushes and brooms. The coquilla-nut is the fruit of the same palm.—SUN, shunum, taag, or Bengal hemp, is the fibre of *Crotalaria juncea* (p. 420), a leguminous plant of India, resembling our broom. JUTE (*Corchorus capsularis*), p. 420. The fibre of this plant, which belongs to the Linden tribe, has of late years become so generally used, that it now rivals flax and hemp in its importance as a commercial product.—For other figures, see Index or List of Plates.

PLATE XXXV.

VEGETABLE POISONS.

Æthusium cynapium, fool's-parsley; leaves poisonous. *Arum maculatum*, cuckoo-pint, or wake-robin; tubers amylaceous, stimulant, diaphoretic, and expectorant; juice acrid, poisonous; produces Portland sago when freed from the acrid juice. *Bryonia alba*, white bryony; root acrid and purgative; cathartic. *Chelidonium majus*, greater or common celandine; juice acrid, stimulating, aperient, diuretic, and sudorific.

PLATE XXXVI.

VEGETABLE POISONS.

Aconitum napellus, wolf's-bane, or monk's-hood; narcotico-acrid; a spirituous infusion of the root has proved fatal to human life. *Atropa belladonna*, deadly nightshade or dwale; a dangerous narcotic. *Solanum dulcamara*, woody nightshade or bitter-sweet; berries bitter and poisonous; plant narcotic and diaphoretic. *Datura Stramonium*, common thorn-apple; violent narcotic poison.

PLATE XXXVII.

VEGETABLE POISONS.

Conium maculatum, hemlock; powerfully narcotico-acrid. *Hyoscyamus niger*, black henbane; strongly narcotic. *Lactuca virosa*, poisonous lettuce; narcotic. *Colchicum autumnale*, autumnal meadow-saffron; a narcotico-acrid poison; used as an anthelmintic.

PLATE XXXVIII.

VEGETABLE POISONS.

Ranunculus alpestris, alpine white crowfoot; acrid. *Agaricus muscarius*, fly-blown mushroom (named also *Amanita muscaria*), one of the most poisonous of our fungi. It is narcotic and intoxicating, and in Kamschatka is used in the same manner as ardent spirits. *Digitalis purpurea*, purple foxglove; diuretic, narcotic. *Helleborus niger*, black hellebore, or Christmas rose, same natural order as Ranunculus; characterized generally by acridity, causticity, and poison.

PLATE XXXIX., XL.

FRUITS AND NUTS.

Fig. 6.—Sapucaya, Sapucaia, or Zabucajo nut (the produce of *Lecythis ollaria*), and known by the name of monkey-pot, the seeds being much relished by these animals. Fig. 7.—Brazil, Juvia, Castanha, or Para nut (the fruit of *Bertholetia excelsa*), of which also the monkey is very fond, and will hammer the capsule for hours together with a stone, in order to get at the inclosed nuts.—For other figures, see Index or List of Plates.

PLATE XLI.

AUSTRALIAN TREES AND SHRUBS.

Australian trees as well as shrubs are perennial evergreens. Hence the forests of that vast island are verdant with foliage all the year round. There is no autumnal fall of the leaf; consequently there is scarcely any soil formed in the woods by decayed leaves. As there is no general denudation of leaves from the branches in winter, so, when spring comes round, no universal budding takes place, to renew the charms of that season, as in European forests. The well-known American expression, "fall of the year," which is derived from its deciduous vegetation, is in this southern region inapplicable. There is a *stereotyped* aspect, if we may so term it, about Australian forest scenery, so that its general effect upon the mind is that of monotony. This impression is likewise assisted by the sombre green colour of the foliage, caused by the dark tint of the chlorophyll that constitutes the colouring matter of the leaves. Although the country is open and grassy, and the climate clear and sunny, yet there are no warm green hues in the forest landscape in spring, nor the rich glowing tints of autumn. A universal sombreness would thus prevail, were these effects not consider-

ably modified by the unusual structure of the leaves and bark of the trees belonging to the genus *Eucalyptus*, which form, on an average, four-fifths of the forests in the temperate regions of Australia.

It is well known that, in forests of deciduous trees, the leaves project horizontally from the leaf-stalk, showing a distinct upper and under side in the structure of their veins, parenchyma, and epidermis. This position of the leaves gives that umbrageous character to our forest trees which is well marked in the sycamore and chestnut. In Australia, on the contrary, gum-trees and their congeners have their leaves placed *vertically* upon the leaf-stalk, both sides being of the same structure, like the mistleto leaf. Consequently there is abundance of light from above piercing these forests, rendering more cheerful what would otherwise be gloomy in the Australian landscape, and permitting the sun's rays to penetrate through the foliage, so as to fall upon the brilliant-coloured flowers and green-sward which cover the open forest lands, as it were, with a beautiful carpet. Moreover, the leaves of this class of trees are rarely more than an inch wide and five inches long, being simple, acute, and scimitar-shaped, the branches but thinly covered with foliage, and the trees wide apart; so that, excepting their monotonous character, the open forests of Australia are cheerful to the traveller, salubrious to the settler, and are always well lighted up by the sun and swept by the breeze. The autumnal fall of the leaf is likewise in some measure represented by the annual stripping of the bark from the trunks and branches of the gum trees, which is seen in the accompanying plate, fig. 1.

Of an opposite character is the general appearance of the brushwoods, formed by shrubs and the class of smaller trees in Australia. These thickets, termed "scrubs" by the colonists, are dark, dank, and dreary, and the plants so closely interwoven and thorny that in many instances they are impenetrable by man or beast. The contrast between them and the neighbouring open forest land is remarkably defined. While in the latter, as we have remarked, all nature is dry, light, and cheerful, in the former the traveller scarcely proceeds twenty steps when he is enveloped in gloom, even at mid-day, while a hollow, resounding canopy of foliage, formed of broad-leaved climbers, fig-trees, laurels, and the like, echoes to his progress, as he forces his way through the crackling brushwood, whilst a damp chill seizes his frame. Here the botanist finds many of the rarest and most beautiful Australian shrubs and trees, and, what is remarkable, rarely of the same species as those which grow outside its boundary. That indefatigable explorer and botanist, the lost and lamented Leichhardt, informed the writer of this article that in the Moreton Bay district he counted seventy species of shrubs and trees, within the area of a square mile, in one of these scrubs, not one of which was found in the adjacent forest.

This remarkable feature is partly accounted for from the tenacity with which these scrubs keep to soils formed by certain rocks. In one locality they grow upon the trap-dikes which intersect the sandstone formation, forming narrow belts of vegetation, not more than one or two miles wide, and continuing dense and unbroken for five, ten, fifteen, and frequently twenty miles. So that if the direction of one lies across the path of the settler, between his homestead and the settlement, he has either to skirt it, making a circuitous route, or to cut a road through it. In other localities the nature of the soils is reversed, as shown by Leichhardt, during his journey from Moreton Bay to Port Essington. "It was interesting," he writes, "to observe how strictly the scrub kept to the sandstone and stiff loam lying upon it, whilst the mild black whinstone was without trees, but covered with luxuriant grasses and herbs; and this fact struck me as remarkable, because, during my travels in the Bunya country of Moreton Bay, I found it to be exactly the reverse; the sandstone spurs of the range being there covered with an open well-grassed forest, whilst a dense vine brush extended over the basaltic rock." The greatest known jungle of this kind lies between Melbourne and Gipps' Land, in Victoria, which is estimated to be nearly 200 miles long and about 50 broad; and although a track has been found across it, so difficult is the journey through its rocky region, that it takes the intrepid bushman three days to cross it.

White Gum-Tree (*Eucalyptus obliqua*), Fig. 1.—The genus *Eucalyptus* derives its name from the well-marked connection of the calyx with its lid or *calyptra*, which is forced off by the pistils and stamens, when blossoming. The gum trees of Australia are the monarchs of the forest in that country, and attain the height frequently of 150 feet, with a girth of 24 feet about a yard from the ground. In Van Diemen's Land this may be considered the average dimensions of the trees in the southern and western parts of the island, where we have measured a fallen giant of the forest 260 feet in length and 16 feet in diameter. However, the buts of such enormous trees are not solid. At the same time, some idea of their size may be entertained, when from two to four men on horseback can find room in their hollow trunks. The appearance of a white-gum tree forest has no counterpart in the northern hemisphere. From the base of the trunk up to the minutest branches, the bark of the tree is perfectly white, and the leaves of a leek-green colour. Its general aspect is that which a forest of ash trees would have, if their stems and branches were white-washed. Their trunks, also, are generally naked for about two-thirds of the way up; and the branches above that project at nearly right angles from them, while the smaller branches frequently shoot up vertically. The leaves show the specific character of the foliage alluded to, particularly their leathery structure. On being crushed in the hand, an essential oil is expressed from them, which is contained in cavities, to preserve them during their perennial existence, and to enable them to withstand the aridity and heat of the climate. As the name denotes, trees of this genus exude gum from their trunks. This gum, however, is not a true gum, like that which is yielded by the Acacias. It is, properly speaking, a

gum resin, of a highly stringent quality, possessing similar properties to gum-kino, and as such is a valuable corrective in dysenteric complaints, which are often fatal amongst the colonists.

STRINGY-BARK (*E. pulverulentus*), Fig. 2.—The timber of the white and blue gums, as well as their ally the stringy-bark, is of the most serviceable description to the colonists. Though all are equally useful for the same purposes, yet the white gum is especially valued in house-building, while blue gum excels it for ship-building. Ships built of this timber are classed at Lloyd's A 1 for fourteen years. Stringy-bark is a more straight-grained timber than either of the others, and hence it is sought after for splitting into paling, laths, and shingles; the latter being used for roofing houses instead of slates. On the other hand, there are cross-grained gum trees of so tough a nature, that ships' knees may be cut by the saw out of a plank, and have all the strength of a naturally-bent knee. It is remarkable, also, that the best timber from the gum trees is the outside part, the inside often being hollow and decayed; and it is no unusual circumstance for the ship-builders at Hobart Town to lay down the keel of a ship 120 feet long, composed entirely of a single slab from the outer portion of a gum tree.

THE WATTLE TREE (*Acacia dealbata*), Fig. 3.—There are about forty species of acacia in Australia, all ornamental trees, but none exceed the wattle tree in beauty, nor approach it in point of utility. It forms umbrageous and delightfully scented groves near the banks of streams and lakes. It is a handsome tree, from fifteen to thirty feet high, with minutely pinnate leaves, like the mimosa plant, from which circumstance its bark is called the mimosa bark, and forms an article of export from Australia to Britain; which, before the gold discovery, amply remunerated the exporter, notwithstanding the great distance, from the fact of its containing a greater percentage of the principle *tannin* than any other bark. It is most abundant in Van Diemen's Land, Port-Philip, and Twofold Bay, and other parts of the south coast, between the parallels of 34° and 38° south latitude. The flower is a ball of yellow stamens and pistils, from which insects derive much nourishment. When the acacia groves are in full blossom, they send forth a fragrance which may be detected at the distance of several miles; and on approaching them they present one of the most picturesque features in Australian forest scenery. This plant yields a gelatinous gum of no value for the purposes of commerce; but its congener, *A. implexa*, furnishes a soluble gum, little inferior to gum Arabic, and formerly was an article of export from South Australia to this country.

AUSTRALIAN VIRGIN BOWER (*Clematis Mossmana*), Fig. 4.—This beautiful climbing plant was discovered by Mr. Mossman amongst the scrub forests of the Australian Alps. It has a four-leaved white waxy calyx, two to three inches in diameter, inclosing a profusion of yellow stamens and styles, which give forth a delicious orange perfume. The flowers blossom from October until January. Towards March and April its beauty is scarcely diminished, although the flowers are gone; for these are succeeded by fasciculæ of long feathery awns, depending from the pericarp, like bundles of floss silk. In the locality above named, it climbs up the trunks and through the branches of casuarina and araucaria trees, hanging in festoons from tree to tree, its climbing stem, sometimes fifty feet long, with trifoliate leaves, and serrated cordato-ovate leaflets. Nothing can exceed the delicacy of contrast between the form and colour of this climber amongst the foliage of these darkest of the dark-hued Australian trees. Even the aborigines of the country are not insensible to its beauty, particularly at seed-time, when it waves its silky hair. These dusky children of nature at that time adorn their heads with the stems, entwining them several times round, thereby forming a silvery wreath round their jet-black hair, which upon the young women of the tribes has a most pleasing effect.

GRASS TREE (*Xanthorrhea hastilis*), Fig. 5.—Amongst the many curious forms of the vegetable kingdom in the antipodean world, the grass tree ranks not the least interesting. In general its presence is indicative of a poor soil, therefore it is one of those plants which give life to the sterility of a great portion of Australia. It is an endogenous plant, and attains its height from the annual decay of its long grass-like leaves, from the centre of which proceeds the flower-stalk, in every way having the form and structure of the bulrush. From the bush-fires which sweep through the country, the crooked stems of these plants are almost always scorched black, so that in the distance they have very much the appearance of an aborigine crouching down. That they themselves know this to be the case has been shown, in instances where they have been pursued by the mounted police and squatters, after some murder or depredation. In order to avoid pursuit, the more cunning amongst them would twist their bodies in a contorted manner, and stand immovable until their pursuers had passed, unless the hounds used upon these occasions would scent them out, and prove them to be other than grass trees. Again, the explorer, in passing through a country inhabited by hostile natives, frequently takes these trees, in the distance, to be groups of black men. When torn up by the root after these frequent burnings, a quantity of a resinous gum, called gum acaroides, is gathered in nodules, which has been found useful in manufacturing varnish. The natives use this gum for fastening on the barbs of their spears, made from fishes' teeth or broken pieces of glass.

EVERLASTING FLOWERS (*Helichrysum elatum* and *bracteatum*), Figs. 6 and 7.—An arid region like Australia is necessarily rich in specimens of dry everlasting flowers, white and yellow. These gaudy flowers form a great contrast with the surrounding brushwood, where they grow, or at other times in the clefts of rocks on the summits of mountains. For it would appear that their hardy nature is proof against sun and wind at the highest altitudes of Australian vegetation, while the barren mountain-ridges furnish sufficient soil for their nourishment where other

plants would perish. They are favourites with the aboriginal women in decorating their hair.

She-Oak (*Casuarina pendula*), Fig. 8, is one of those arborescent plants, typical of extinct European vegetation, of which there are so many examples in the Australian flora. It bears the anomalous name of she-oak amongst the colonists, which is a corruption of the native name *sheack*. Although an exogen in the structure of its branches and trunk, which displays an unusually large development of the medullary rays, the casuarina possesses no true leaves. The pendulous articulations which serve for that purpose, are formed in the same manner as the whorls of *Hippuris vulgaris*, the common mare's tail, and these are analogous in structure to the lepidodendra of the transition epoch, as seen in their fossil remains, so that the *casuarinæ* of Australia may be considered existing types of the extinct arborescent *equisetaceæ*, which flourished during the carboniferous era, and assisted greatly in forming the strata of the coal-measures. Their average height is from fifteen to twenty feet, the trunks disproportionately thick compared to their size, and spreading out at the but with thick, firmly imbedded roots. The colour of its scanty foliage is of the darkest green, which, together with the dark hue of its rough bark, renders a clump of those trees like a black patch in the landscape. Its usual habitat is by the borders of running streams, and hence it is regarded especially by the settlers in that arid country. But its most characteristic location is by the sea-side, where it flourishes in dense groves. Here, upon the poorest soil, and at the utmost verge of the land, these hardy trees brave the salt spray, which showers upon them from the surf. While we have designated the gum tree forests as cheerful, though monotonous, and the vine scrubs as dense and gloomy, these casuarina groves may with equal propriety be called melancholy. Seated under the dark canopy of thread-like foliage, the winds sigh overhead as they create a stridulous murmur amongst the leaves, producing a mournful sound, which is heightened by the distant surge of the ocean. The leaves are nourishing, and relished by horses and cattle, while, on the ground where they fall, they prevent the vegetation of grasses and herbs, and are slow in decomposition. The timber is of a hard and tough kind, and is much prized by the aborigines, who cut their boomerangs and clubs from portions of the but, while the tree is growing.

Cabbage-Palm (*Corypha Australis*), Fig. 9.—As a contrast to the foregoing in pleasing beauty and habitat, we may class the cabbage-palm. Their graceful stems and light green leaves shun the bleak hillside, and seek for shelter in the warm fertile meadow-lands. In clearing these rich patches of alluvial soil, the farmer rarely cuts down the cabbage-palm, particularly as it is not abundant throughout the colony. Moreover, the leaves, when dried, are highly valued for making men's sailor-brimmed hats. For this purpose they are cut up into strips about the width of a straw, and plaited zigzag fashion, which are sewn strongly together to the required shape; and few hats stand the climate more serviceably than an Australian cabbage-palm hat. The name of cabbage is given to it in consequence of the young leaves, before emerging from their sheath, furnishing a vegetable mass not unlike a cabbage, and which, upon emergencies, the traveller has found a nutritious farinaceous kind of food. Otherwise, this tree is the same as its great congeners found in tropical climates, and attains an average height of fifty feet.

Captain Cook's Tea-Tree (*Leptospermum scoparium*), Fig. 10.—When our distinguished countryman and navigator, Captain Cook, arrived in these distant southern regions, after long and harassing voyages thither, it was amongst his first duties, for preserving the health of his crews, to look for some wholesome herbs on shore, as a corrective to the fatal effects of scurvy. The plant, known throughout Australasia as Captain Cook's tea-tree, was found by him to contain a curative principle in addition to this. A decoction of its leaves drank like tea—hence the name—proved a most efficient medicine. Its leaves are much smaller than those of the tea-plant, but the seed-vessels are very similar. It bears rosaceous white blossoms eight months in the year, and grows most luxuriantly on marshy ground, from six to twenty feet high. What are termed tea-tree scrubs among the settlers, are dense thickets of this plant along the swampy margins of streams, where the stems grow as straight and supple as willow-wands, which are useful in "wattling" the sides of huts, *i.e.*, forming a kind of basket-work upon upright posts, to be covered with mortar. In Van Diemen's Land and New Zealand, where it grows abundantly, the settlers make a palatable and wholesome beer from it; and in Port-Philip, in 1841, when tea rose from £3 to £15 per chest, many of the poorer class of settlers used it as a substitute.

The Bottle-brush Plant (*Banksia marginata*), Fig. 11.—This genus of plants numbers about thirty known species, and is peculiar to Australia. Excepting for firewood, they are of no utility to the settler; yet, in the economy of nature, they form a binding root for the sandy shores of bays and inlets on the coast. They generally present a stunted appearance, with dry rigid leaves, producing the compound flower which gives them their familiar name. This species rarely exceeds six feet in height, but the *Banksia serratifolia* attains sometimes twenty feet.

Dwarf Native Cherry (*Exocarpus humifusus*), Fig. 12.—As contrasting with its dry nature, the dwarf native cherry is distinguished by its succulent properties, and growing in swamps. This species and *E. strictus* bear a small drupe, with the stone at the base outside, which is called the native cherry by the colonists, and possesses a sweet flavour.

Great-flowered Australian Heath (*Epacris grandiflora*), Fig. 13.—This beautiful heath is now a favourite ornamental hot-house plant. Although the *Epacridaceæ* are, strictly speaking, not true heaths, yet plants of that order resemble the *Ericaceæ* in almost every character, excepting that the anthers are one-celled, and opening longitudinally, whereas the others are two-celled, and dehiscing by a pore. In other respects they serve the same economy in nature,

and inhabit similar localities and soils. In the arid, sandy districts of Australia, along the east coast, the different species of *epacris* are as abundant as the *ericas* are at the Cape of Good Hope. Their dry, rigid leaves, brilliantly coloured petals, devoid of scent, and hard woody stems, accord with the bright sunny climate, and the unmarked character of the seasons. The adaptation of these plants to a region where more succulent herbs would soon wither and perish, is beautifully illustrative of the provision of nature in clothing the Australian wilderness with vegetation; while the facts that they flower in our winter gardens, when all European flowers are dead, and fade in summer, when indigenous plants are in full bloom, show that, although transplanted to the northern hemisphere, where the seasons occur in opposite rotation, they retain the wondrous principles of vegetable physiology unaltered, which regulate the nature of vegetation in the southern hemisphere; a proof that there is another and a higher principle controlling the vitality of plants than heat, and its alternations of cold. Nothing can surpass their beauty when seen growing in the greatest luxuriance, amongst the rocky clefts around the shores of Port Jackson. The traveller who sees them for the first time would imagine that he was trespassing upon some horticulturist's garden, and had entered a choice collection of cultivated flowers, when he had suddenly penetrated into one of those flowery dells.

Native Rose of Australia (*Boronia serrulata*), Fig. 14.—For want of a better representative of the "queen of flowers," the Australian colonists have chosen this pretty little plant, which bears but a very distant affinity to the true rose. In like manner, *Correa speciosa*, fig. 15, is named the Australian Fuschia, with perhaps a little closer resemblance to its assumed prototype. This desire of giving familiar names to the flowers of his adopted country, recalls pleasing reminiscences to the colonist; but at the same time it gives the inhabitants of the mother country erroneous impressions of the character of that exotic flora. Not only are the trees and shrubs very different in their nature from those of Europe, but the specific characters of the herbs and grasses are unlike any that are described in the British flora; and we question if there are more than twenty known species of plants common to Australia, which are indigenous in Europe. This statement will convey the extent of its meaning more fully, when we add, that at present there is little short of 10,000 species known to botanists, although not all botanically described. The first botanist of repute who visited the shores of Australia, and gave some account of its extraordinary vegetation, was the late Sir Joseph Banks, who was afterwards followed in his researches by the indefatigable Robert Brown, at present chief botanical curator in the British Museum. This gentleman gave the result of his discoveries in a purely technical work, published in Latin, as far back as 1810, wherein he describes upwards of 4500 species, and which, from the umbrage taken by its author at the severe criticisms passed on his new views, and style of Latin, never passed into a second edition, and may be considered a sealed book to the public at large. Since that period very little has been done in describing and illustrating the botany of that most interesting region. Few *genera* have been added to the list given by that eminent botanist, although Cunningham, Labillardiere, and others, have more than doubled the list of species. There is still a vast field open for botanical discoveries in Australia, and a popular and interesting history of its vegetation has yet to be given to the world.

S. M.

GLOSSARY

OF

BOTANICAL TERMS.

A

A, in composition, signifies without, as *Aphyllus*, without leaves; *Acaulis*, without stem.
Abbreviate (*abbreviare*, to shorten). Used in comparative descriptions, to indicate that one part is shorter than another.
Aberrant, deviating from the natural or direct way; applied in Natural History to species or genera that deviate from the usual characters of their neighbours.
Abortion signifies an imperfect developement of any given organ.
Abraded, rubbed or worn off.
Abstergent, cleansing, having a cleansing quality.
Accessory, something added to the usual number of organs, or their parts.
Accretion, the growing of one thing to another.
Accumbent, lying on, prostrate, supine; this term is employed in Cruciferæ, to signify a radicle, which lies upon the edge of the Cotyledons.
Acerose, needle-pointed; fine and slender, with a sharp point.
Acescent, sour, tart, acid.
Acetarious, any thing belonging to the salad tribes of vegetables.
Acetous, something that produces acidity.
Acicular, needle-shaped.
Acinaciform, scimitar-shaped.
Acini, the small stones in grapes, strawberries, &c.
Aculeate, being furnished with aculei or prickles, as distinguished from spines.
Aculei, prickles, sharp hard processes of the epidermis falling off when old; by which character they are distinguished from spines, which do not fall off.
Acuminate, taper-pointed.
Acutangular, having sharp angles.
Adnate, adhering to a thing. Anthers are called adnate when they are attached to the filament by their whole length.
Adult, the full-grown of any thing: full-grown leaves are adult leaves.
Æruginous, having a colour like that of ærugo or verdigris.
Agglomerated, collected in a heap or head.
Aggregate, gathered together; usually applied to a dense sort of inflorescence.
Akenium, a hard pericarpium, containing a single seed, which does not adhere to it; it is the same as the Linnæan *nux*.
Albumen, the substance under the inner coat of the testa, surrounding the embryo; it is sometimes absent.
Alexipharmic, that which counteracts poisons, antidotal.
Alkalescent, having the properties or effects of alkali.
Alveolate, resembling a honeycomb.
Amentum, a catkin; mode of inflorescence.
Amplexicaul, stem-clasping; the base of the leaf surrounding the stem.
Amylaceous, having the properties of starch.
Anastomosing, uniting, or inosculation, of vessels.
Androgynous, producing both male and female sexes on the same root, or in the same flower.
Anfractuose, full of turnings and winding passages.
Angular, composed of, or furnished with, angles.
Angulo-dentate, angularly toothed, or angular and toothed.
Annulations, rings or circles.
Anterior, growing in front of some other thing.
Anthelmintic, capable of killing worms.
Antheriferous, bearing anthers.
Anti-scrophulous, antiscorbutic; efficacious against scurvy.
Antiseptic, efficacious against putrefaction.
Aperient, having a slight purgative quality.
Apetalous, being without petals.
Apex, the summit; generally applied to any thing terminating in a point.
Aphthous, resembling something covered with little ulcers.
Apiculate, terminating in an apiculous or little point.
Apiculous, a small point. This term is generally used when the midrib projects beyond the leaf, forming a little point, or when a small point is very suddenly and abruptly formed.
Apophysis, a swelling beneath the theca of a moss.
Appendix, that which is attached.
Appressed, placed close upon something else: when hairs lie flat upon the surface of a plant, they are said to be appressed.
Approximated, near together.
Apterous, without wings, or the membranous margins which botanists call wings.
Aquatics, growing in or belonging to water.
Arboreous, being a tree, as distinguished from frutescent or shrubby.
Arborescent, having a tendency to become a tree.
Arcuate, curved or bent like a bow.
Areolæ, little spaces or areas on the surface of a thing: the surface of crustaceous lichens is often cracked in every direction; the spaces between the cracks are the areolæ.
Areolated, the adjective of the last term.
Aridity, dryness.
Arillate, having that peculiar appendage called the Arillus. The term is only applied to seeds.
Arillus, a process of the placenta adhering to the hilum of seeds, and sometimes enveloping them.
Aristate, bearded, as the glumes of barley. Many grasses.
Aroma, the spicy quality of a thing.
Articulation, the place where one thing is joined with another, another word for joint.
Asci, small tubes in which the sporules of Cryptogamic plants are placed.
Ascigerous, bearing asci.
Assurgent, rising upward.
Attenuate, made thin or slender.
Auriculated, having an ear-like base.
Awns, the beard or arista of corn.
Axil-flowering, flowering in the axilla.
Axilla, literally the armpit; in plants applied to the angle formed by the union of the leaf and stem.
Axillary, placed in the axilla.
Axis, the line, real or imaginary, that passes through any thing.

B

Baccate, berried, having a fleshy coat or covering.
Bagged, resembling a bag or sack.
Ball, the round central part of the flower of the Stapélia.
Bands, or vittæ, are the spaces between the elevated lines or ribs of the fruit of umbelliferous plants.
Barred, crossed by a paler colour in spaces resembling bars.
Beak, any thing which resembles the beak of a bird; hard short points.
Bearded, having long hair like a beard.
Beardletted, having small awns.
Bicuspidate, twice pointed.
Bidentate, double-toothed, or having two teeth.
Biennial, a plant is said to be biennial which requires two seasons to mature its fruit, and then dies.
Bifarious, placed in two rows.
Bifid, half divided in two; two cleft.
Biglandular, double-glanded.
Bilabiate, having two lips.
Bilobed, divided into two lobes.
Binate, growing two together.
Bipartible, capable of being parted in two.
Bipinnate, a mode of foliation; twice pinnate.
Bipinnatifid, twice pinnatifid, a mode of foliation.
Bisaccate, having two little sacks, bags, or pouches.
Biscutate, resembling two bucklers (*scuta*) placed side by side.
Biternate, divided in three twice over.
Bi-tri-crenate, crenate twice or thrice.
Bi-tri-pinnatifid, pinnatifid twice or thrice over.
Bi-tri-ternate, growing in threes twice or thrice over.
Bivalved, two-valved.
Blanching, made white by being grown in a dark place.
Bland, fair, beautiful.
Blight, a vague term, signifying a pestilence among plants caused by the attack of insects or of parasitical fungi, or by some endemical affection of the atmosphere.
Blistered, having the surface raised as the skin is when blistered.
Bole, trunk of a tree.
Boragineous, of or belonging to the natural order Boragineæ.
Brachiate, having arms or branches usually placed opposite to each other, nearly at right angles with the main stem, and crossing each other alternately.
Bracteate, furnished with bracteæ.
Bracteolæ, little bracteæ.
Bracteæ, small leaves placed near the calyx.
Branchlets, small branches.
Bristles, rigid hairs.
Bulbiferous, bulb-bearing.
Bulbous, having bulbs.
Bulbs, underground buds resembling roots, and consisting of numerous fleshy scales placed one over the other.
Burry, covered with hooked stiff hairs, like the heads of Bur or Burdock.
Byssoid, having the appearance of Byssi.

Caducous, falling off soon.
Cæsious, gray.
Cæspitose, growing in little tufts.
Calcarate, spurred, or spur-shaped.
Calcareous, chalky, or growing on chalk.
Calceiform, formed like a little shoe.
Calli, small callosities, or rough protuberances.
Callous, hardened.
Calycine, of or belonging to a calyx.
Calyculated, having bracteolæ resembling an external or additional calyx.
Calyptra, literally an extinguisher; applied to the body which tips the theca of a moss, and the like.
Calyptrate, having a covering resembling an extinguisher.
Calyptriformis, shaped like a calyptra.
Campanulate, bell-shaped.
Canaliculate, channelled or furrowed.
Cancellate, latticed; resembling lattice-work.
Canescent, hoary, approaching to white.
Capillary, very slender; resembling a hair.
Capitate, growing in a head.
Capitular, growing in small heads.
Capituli, small heads.
Capituliform, formed like a small head.
Carbonised, burned to a coal.
Carina, a keel like that of a boat; also the two lower petals of papilionaceous flowers.
Carinate, keel-shaped.
Cariopsis, a one-celled, small, indehiscent pericarpium adhering to the seed which it contains, as the grain of grasses.
Carious, decayed.
Carminative, medicines which promote perspiration.
Carnose, fleshy.
Carpella, the small parts out of which compound fruit are formed.
Carpology, the science which treats of the structure of fruits and seeds.
Cartilage, gristle.
Cartilaginous, gristly.
Cataplasm, a plaster, or more properly a poultice.
Catarrhal, of or belonging to a cold.
Cathartic, purgative.
Catkin, inflorescence of the natural order Amentáceæ.
Caudate, tailed, being like a tail.
Caudex, the trunk or stem.
Caudicula, a small membranous process on which the pollen of orchideous plants is fixed.
Caulescent, acquiring a stem.
Cauline, produced on a stem.
Causticity, having a burning quality.
Cautery, that which burns.
Cellular, composed of cells.
Centimetre is a French measure equal to 4 lines $\frac{432}{1000}$ or near 4½ lines.
Centuriæ, hundreds.
Cephalic, medicinal to the head.
Ceraceous, wax-like.
Cernuous, nodding, drooping, or pendulous.
Chaffy, bearing processes resembling chaff.
Chalaza, a spot on the seed, indicating where the vessels of the raphe terminate.
Channel-leaved, folded together so as to resemble a channel for conducting water.
Charring, blackening by fire.
Ciliæ, hairs like those of the eyelash.
Ciliary processes, like eyelash hairs.
Ciliated, eyelash-haired.
Ciliato-dentate, toothed and fringed with hairs like eyelashes.
Cinereous, ash-coloured, gray.
Circinately, curled round like a sharp crook.
Cirrhiferous, bearing tendrils.
Cirrhose or *Cirrhous*, tendrilled.
Clammy, viscid, sticky.
Clathrate, latticed, divided like latticework.
Clavate, club-shaped.
Clavellose, clubbed, or having club-like processes.
Clavus, a name for the ergot, a disease in corn.
Claws, the taper base of a petal.
Clinandrium, that part of the column of orchideous plants in which the anther lies.
Clypeate, shaped like a Roman buckler.
Cobwebbed, covered with loose hairs, as if with a cobweb.
Cochleate, resembling the shell of a snail.
Cohering, connected.
Collapsion, the act of closing or falling together.
Columella, the axis of the fruit of mosses.
Columnar, formed like columns.
Comminuted, pulverised or pounded.
Comose, this term is used to express a kind of inflorescence, which is terminated by sterile bracteæ.
Compact, close, solid.
Complicate, folded together.
Complicato-carinate, folded together so as to form a sort of keel.
Compound, used in botany to express the union of several things in one: thus, a compound umbel is formed by several simple umbels, a compound flower by several simple flowers, &c.
Compressed, pressed together.
Concave, hollow.
Concentric, points or lines at equal distances from a common centre.
Concrete, hardened or formed into one mass.
Cone, a particular kind of compound fruit.
Conferruminate, united together so as to be undistinguishable.

Confervoid, like confervæ.
Confluent, running into one another.
Conglobated, collected into a spherical form.
Conical, resembling a cone.
Conico-hemispherical, between conical and round.
Conico-ovate, between conical and ovate.
Conjugate, joined in pairs: a term chiefly applied to leaves.
Connate, joined together at the base.
Connivent, converging.
Conoid, cone-like.
Constricted, tightened or contracted in some particular place.
Converging, approaching together.
Convex, rising in a circular form.
Convexo-plane, plane on one side, convex on the other.
Convolute, rolled together.
Coralloid, like coral.
Cordate, heart-shaped.
Coriaceous, leathery.
Corneous, horny, of the consistence of horn.
Corniculate, having processes like small horns.
Cornute, horned.
Corona, literally a crown: applied in botany to the crown-like cup which is found at the orifice of the tube of the corolla in Narcissus, Pancrátium, and others.
Corpuscle, a small body; a particle of any thing.
Corroborant, strengthening, having the power to give strength.
Corrosive, having the power of wearing away.
Corrugated, wrinkled or shrivelled.
Cortical, of or belonging to the bark.
Corymb, a raceme or panicle in which the stalks of the lower flowers are longer than those of the upper, so that the flowers themselves are all on the same level.
Corymbose, formed or arranged after the manner of a corymb.
Corymbulose, formed or arranged in many small corymbs.
Cosmetic, beautifying.
Costæ, literally ribs: applied by botanists sometimes to the midrib of a leaf, and sometimes to any projecting round elevations having the same direction as the axis of the fruit.
Costate, ribbed.
Cotyledons, seed lobes or leaves.
Cowled-leaved, a thing is said to be cowled or cucullate when its end is curved inwards in such a manner as to represent the cowl or hood of a monk.
Crenæ, notches.
Crenate, notched.
Crenature, the notching.
Crenulate, full of notches.
Crest, applied to some elevated appendage terminating a particular organ: a stamen is crested when the filament projects beyond the anther, and becomes dilated.
Cribriform, riddled with holes like a sieve.
Cribrose, perforated like a sieve.
Crisp, when leaves are very much undulated at the margin, they are called crisp or curled.
Cruciate, shaped like a Maltese cross: a flower is said to be cruciate when four equal petals are placed opposite each other at right angles.
Cruciferous, the name of a particular family of plants bearing cruciate flowers.
Crustaceous, having a hard brittle shell.
Crystalline, consisting of, or resembling, crystals.
Cucullate, hooded, cowled; see *Cowled*.
Culm, the stem of grasses, scitamineous plants, and the like.
Culmiferous, producing culms.
Cultrate, shaped like a pruning-knife.
Cuneate, wedge-shaped.
Cup, the same as corona; see that word.
Cupule, the cup of an acorn, and of all amentaceous plants.
Cupuliform or *Cupulate*, shaped like a reversed bell.
Cuspidate, like the point of a spear, a leaf is cuspidate, when it is suddenly tapered to a point.
Cutaneous, relating to the skin.
Cuticle, the scarf skin, or epidermis.
...t-toothed, cut and toothed at the same time
...form, cup-shaped, concave.
...ous, having the form of a cylinder.
Cylindrical, cylinder-shaped.
Cylindrico-campanulate, cylindrically bell-shaped.
Cymbiform, boat-shaped.
Cyme, a mode of inflorescence, resembling a flattened panicle.
Cymose, flowering in cymes.

D

Decandrous, having ten stamens.
Deciduous, falling off. Leaves which are shed annually are said to be deciduous: as are also trees that annually lose their leaves.
Declinate, curved downwards.
Decoction, a preparation or digest by boiling water.
Decompound, a leaf is said to be decompound when it is twice pinnated; a panicle when its branches are also panicled.
Decorticated, disbarked.
Decumbent, lying down.
Decurrent, running down.
Decursive, having a tendency to run down.
Decussated, when two right lines cross each other at right angles they are said to decussate; leaves are often placed in this position.
Deflexed, turned downwards.
Dehiscent, gaping; an expression applied to the mode in which the anthers or the fruit burst open and discharge their contents.
Deliquescent, melting away upon exposure to air.
Delta-leaved, *Deltoid*, shaped like the Greek Δ.
Demulcent, having the property of softening any thing.
Dentate, having the margins divided into incisions resembling teeth.
Dentato-ciliate, having the margin dentate and tipped with ciliæ.
Dentato-sinuate, scolloped and toothed.
Denticulate, being finely dentate.
Denticulations, small toothings.
Dentiform, tooth-shaped.
Deobstruent, having the power of removing obstructions, a term of medicine.
Dependent, hanging down.
Depressed, pressed downward.
Depurated, purified, cleansed.
Despumate, to throw off in froth or scum.
Detergent, *Detersive*, having the power of cleansing
Diandrous, having two stamens.
Diaphanous, transparent.
Diaphoretic, promoting perspiration.
Dichotomous, a stem that ramifies in pairs.
Dicoccous, having two cocci.
Didymous, two united.
Didynamous, having two long stamens and two short ones in the same flower, each pair being collateral.
Difform, two forms; used to express irregularity.
Diffuse, scattered, widely spread.
Diffusible, such as may be spread.
Digitated, fingered, shaped like the hand spread open.
Digitiform, formed like fingers.
Digynous, two styles or female organs.
Dimidiate, halved, divided into two parts.
Diœcious, when a plant bears female flowers on one individual, and males on another, it is called diœcious.
Discoid. When in Compósitæ the florets are all tubular, the head of flowers is said to be discoid. In other cases, when the florets of the centre of a head of flowers are more perfect than the rest, they are called discoid. Finally, when any thing is dilated into something which may be compared to a disk, the term discoid is also made use of.
Discus or *Disk*, the fleshy annular process that surrounds the ovarium of many flowers: also the surface of a leaf; also the centre of a head of flowers of Compósitæ.
Discutient, having the power to scatter the matter of tumours.
Dissepiment, the partitions by which a seed vessel is divided internally.
Distichous, two-rowed: producing leaves or flowers in two opposite rows
Ditrichotomous, divided in twos or threes; a stem continually dividing into double or treble ramifications.
Diuretic, having the power of promoting the flow of urine.
Divaricate, growing in a straggling manner.
Dodecandrous having twelve stamens.

Dolabriform, axe-shaped.
Dorsal, growing on the back.
Drastic, applied to medicines which act violently.
Drupe, a kind of fruit consisting of a fleshy succulent rind, and containing a hard stone in the middle.

E

Echinated, covered with prickles like an echinus or hedgehog.
Edible, eatable.
Effuse, literally poured forth; applied to inflorescence, it means a kind of panicle with a very loose one-sided arrangement.
Electuaries, a medicine of conserves and powders in the consistence of honey.
Ellipsoid, like an ellipsis.
Elliptic-lanceolate, a form between elliptical and lanceolate.
Elongated, lengthened.
Emarginate, having a small notch in the end.
Embossed, projecting in the centre like the boss or umbo of a round shield or target.
Embracing, a leaf is said to embrace a stem when it clasps it round with its base.
Emollient, softening.
Emulsions, medicines made of bruised oily seeds and water.
Ensate or *Ensiform*, shaped like a sword with a straight blade.
Epidermis, the outer skin of the bark.
Epiphyllous, growing upon a leaf.
Epiphytes, plants which grow upon other plants without deriving any nutriment from them.
Equidistant, equally distant.
Equilateral, having equal sides.
Equitant, a mode of vernation, or of arrangement of leaves with respect to each other, in which the sides or edges alternately overlap each other.
Erecto-patent, between erect and spreading.
Eroded, gnawed, bitten; a term used to express a particular kind of irregular denticulation.
Eroso-dentate, the toothing being eroded.
Errhine, promoting a discharge of mucus from the nostrils.
Escharotic, having the power to scar or burn the skin.
Esculent, good for food.
Etiolated, whitened by being kept from air and light.
Evanescent, quickly vanishing.
Evolved, unfolded.
Excavated, hollowed out.
Excentrical, flying off from the centre.
Excoriate, stripped of the bark or skin.
Excurrent, projecting or running beyond the edge or point of any thing.
Exotic, foreign.
Expectorant, any thing that promotes the discharge of mucus from the chest.
Exserted, projecting beyond something else.
Exsiccated, dried up.
Extra-axillary, above or on the outside of the axils.
Extra-foliaceous, away from the leaves, or inserted in a different place from them.
Exuviæ, whatever is cast off by plants or animals.

F

Fæcula, the nutritious powder of wheat or of other things.
Falcata or *Falciform*, bent like a sickle.
Farinaceous, full of flour.
Fascicles, parcels or bundles.
Fasciculate, arranged in bundles or parcels.
Fastigiate, tapering to a narrow point like a pyramid.
Fauces, the jaws; the gaping part or orifice of a monopetalous flower.
Favose, pitted or excavated like the cells of a honeycomb.
Feathery, resembling a feather.
Febrifuge, efficacious in moderating fever.
Feculent, muddy, thick with sediment.
Fecundation, the act of making fruitful.
Feroces, thickly set with spines.
Ferruginous, iron-coloured, rusty.
Fibrillose, covered with little strings or fibres.
Fibrous, being composed of fibres.
Fiddle-lipped, having a lip resembling the figure of a fiddle.
Filiform, shaped like a thread.
Fimbriate, fringed.
Finger parted, divided into lobes having a fanciful resemblance to the five fingers of a human hand.
Fistular or *Fistulous*, hollow like a pipe.
Flaccid, feeble, weak.
Flexile, capable of being bent in different directions, pliable.
Flexuose, having a bent or undulating direction.
Flexuose-recurved, bent backward in a flexuose or undulated manner.
Flocci, little tufts like wool.
Floræ horologicæ, flowers which expand at particular hours, whence they are a sort of timekeepers.
Floral envelopes, the calyx, bracteæ, and corolla, which envelope the inner parts of the flower are all so called.
Florets, little flowers; chiefly applied to those which constitute what were formerly called compound flowers.
Floriferous, that which bears flowers.
Flosculous, compound flowers, consisting of many tubulose monopetalous florets.
Foliaceous, having the form of leaves.
Follicle, a particular kind of seed-vessel.
Footstalks, the stalks of either flowers or leaves.
Fornicate, arched.
Fragmentary, composed of fragments.
Fringed, having a border like a fringe.
Frond, the leaves of palms.
Frontal, that which is in front.
Frosted, covered with glittering particles, as if fine dew had been congealed upon it.
Fructification, all those parts composing the flower and fruit of plants.
Frutescent or *Fruticose*, shrubby.
Fugacious, that which lasts but for a short time.
Fulvous, tawny yellow or fox-coloured.
Fungous, having the substance of fungi or mushrooms.
Funicle, the little stalk by which a seed is attached to the placenta.
Furcate, forked.
Furfuraceous, scaly, mealy, scurfy.
Fuscous, blackish-brown.
Fusiform, spindle-shaped.

G

Galeate, helmeted; the upper lip of a ringent corolla is the galea of that corolla.
Gelatine, jelly; a term of chemistry.
Gelatinous, consisting of jelly.
Geminate, doubled.
Gemmæ, leafy buds as distinguished from alabastra or flower buds.
Geoponic, relating to agriculture.
Germ or *Germen*, the old name of the ovarium.
Germen inferior, fruit below the flower.
Germination, the first act of vegetation in a seed.
Gibbous, protuberant.
Glabrous, smooth.
Gladiate, shaped like a short straight sword.
Glandular, having glands.
Glaucescent or *Glaucine*, having something of a bluish hoary appearance.
Glaucous, having a decided hoary gray surface.
Globose or *Globular*, round or spherical.
Glomerate, gathered into a round heap or head.
Glumaceous, plants are said to be glumaceous when their flowers are like those of grasses.
Glume, a part of the floral envelopes of a grass.
Gluten, a chemical principle.
Glutinous, adhesive.
Grained, the segments of the flowers of Rumex have tubercles which are called grains.
Graniform, formed like grains of corn.
Granular, covered as if with grains.
Gregarious, herding together.
Grooved, furrowed, channelled, marked with grooves.
Grumous, clubbed, knotted, contracted at intervals into knots.
Gynandrous, having the stamens and style combined in one body.
Gyrose, turned round like a crook.

H

Habit, features or general appearance of a plant.
Hastate, formed like the head of a halbert.
Hastato-lanceolate, between halbert-shaped and lanceolate.
Hastato-sagittate, between halbert-shaped and arrow-shaped.
Haulm, dead stems of herbs.
Helmet, the same as *Galea;* see Galeate.
Herbaceous, a plant the stem of which perishes annually.
Hermaphrodite, consisting of two sexes.
Hexagonal, six-sided.
Hexandrous, having six stamens.
Hexangular, six-angled.
Hexapetalous, having six petals.
Hilum, the scar or mark on a seed which indicates the place by which it adhered to the placenta.
Hirsute, rough with soft hairs.
Hispid, rough with stiff hairs.
Hoary, covered with white down.
Homogeneous, having a uniform nature, or principle, or composition.
Honey-pore, the pore in flowers which secretes honey.
Honey-scales, the scales in flowers which secrete honey.
Honey-spots, the spots in flowers which secrete honey.
Hooded, being curved or hollowed at the end into the form of a hood.
Horn, any long subulate process in a flower is called a horn.
Husks, the dry envelopes of either flowers or fruits.
Hyaline, crystalline, transparent.
Hybrid, mule; partaking of the nature of two species.
Hygrometrical, indicating the approach of moisture.
Hypocrateriform, salver-shaped.
Hypogynous, situated below the ovarium.
Hypophyllous, under the leaf.

I

Iced, covered with particles like icicles.
Ice-drops, transparent processes resembling icicles.
Imbricate, laid one over another like tiles.
Incised, cut, separated by incisions.
Incrassated, becoming thicker by degrees.
Incurved, bending inward.
Incurve-recurved, bending inwards and then backwards.
Indehiscent, not dehiscing.
Indigenous, native of a country.
Indurated, hardened.
Indusium, the membrane that encloses the theca of ferns.
Inflated, blown up.
Inflexed, bending inward.
Inflorescence, disposition of flowers.
Infundibuliform, funnel-shaped.
Innocuous, harmless.
Inspissated, thickened; spoken of sap or other liquor.
Intenerating, having the power of making tender or softening.
Internodes, the space between the joints of plants.
Interpetiolar, between the petioles or leafstalks.
Interstices, spaces between one thing and another.
Intramarginal, within the margin.
Inverse, inverted.
Involucels, the partial involucra of umbelliferous plants.
Involucral, having an involucre.
Involucrated, covered with an involucre.
Involucre or *Involucrum*, the bracteæ which surround the flowers of Umbelliferæ in a whorl.
Involute, rolled inwards.

J

Joints, the places at which the pieces of the stem are articulated with each other.
Juliform, formed like an amentum or catkin.

K

Kaliform, formed like Sálsola káli, a sea-coast plant.
Keel, when the midrib of a leaf or petal is sharp and elevated externally it is called a keel.
Kneed or *Knee-jointed*, bent like the knee-joint.

L

Labellum, the front segment of an orchideous or other flower.
...iæ, segments of any thing.
... cut or divided into segments.
Lactescent, yielding milky juice.
Lacunæ, little pits or depressions.
Lacunose, covered with little pits or depressions.
Lævigated, smoothed.
Lamellated, divided by plates internally.
Lamina, literally a plate: it is mostly applied to the leaf of a plant considered without its petiole.
Lanceolate, lance or spear shaped.
Lanceolato-subulate, between lanceolate and subulate.
Lateral, on one side.
Lax, loose, not compact.
Leaflets, small parts of compound leaves.
Legume or *Legumen*, a pod; the fruit of leguminous plants.
Leguminous, plants which bear legumes, such as the pea, the bean, the kidneybean.
Lenticular, shaped like a lens.
Lentiform, in form like a lens.
Leprous, covered with spots or scales.
Lid, the calyx which falls off from the flower in a single piece.
Lingula, the membrane at the top of the petiole of grasses and other plants.
Lingulate, strap-shaped.
Limbate, having a coloured or dilated surface.
Linear, when the two sides are parallel.
Linear-ensate, long sword-shaped.
Linguiform or *Lingulate*, tongue-shaped.
Lipped, having a distinct lip or labellum.
Lobelets, small lobes.
Locomotion, motion from place to place.
Loculaments, partitions or cells of a seed vessel.
Locular, a fruit is called unilocular if it contains but one cell (*a*), bilocular if two cells (*b*), trilocular if three (*c*), and so on.
Loment, a kind of legume falling in pieces when ripe.
Lomentaceous, bearing pericarpia, called lomenta.
Lorate, shaped like a thong or strap.
Lubricate, to make slippery.
Lucid, bright, shining.
Lunate or *Lunulate*, shaped like a half moon.
Lurid, a colour between purple, yellow, and gray.
Lymphatic, of or belonging to lymph or sap.
Lyrate, lyre-shaped.

M

Macerate, to decompose by steeping in water or other liquid.
Marginal, relating to the margin.
Masticatory, grinding or chewing with the teeth.
Math, an old term for crop.
Matrix, a place where any thing is generated or formed.
Medulla, the pith of a plant.
Medullary, relating to the pith of plants.
Melastomaceous, partaking of the nature or appearance of Melástoma.
Melliferous, honey-bearing.
Membranaceous or *Membranous*, having the texture of a membrane.
Menstruum, a liquor used as a dissolvent.
Meshes, the openings in any tissue.
Micacious, glittering, shining.
Midrib, the large vein which passes from the petiole to the apex of a leaf.
Miliary, granulate resembling many seeds.
Mitriform, formed like a mitre.
Mobility, the power of motion.
Monadelphous, having the filaments cohering in a tube.
Monandrous, having one stamen.
Moniliform, formed like a necklace, that is to say, with alternate swellings resembling beads and contractions.
Monocotyledons, having one seed lobe or leaf.
Monœcious, having the one sex in one flower, and the other in another.
Monopetalous, having one petal.
Monosepalous, having one sepal or division of the calyx.
Mordant, that which enables vegetable matter or tissue to receive dyes or colouring matter, and to retain them.
Mottled, marked with blotches of colour of unequal intensity passing insensibly into each other.
Mucilage, a turbid slimy fluid.
Mucronate, pointed sharp.
Mucronulate, having a little hard point.

Mulch, a gardener's term for the placing manure about the roots of trees on the surface of the ground.
Multifarious, very numerous; or arranged in many rows.
Multipartite, much divided.
Multiplex, much multiplied.
Muricated, covered with short sharp points.
Muricato-hispid, covered with short sharp points and rigid hairs or bristles.

N

Naiades, nymphs of the springs and fountains; a particular order of Monocotyledonous plants.
Narcotic, producing sleep or torpor.
Navicular, boat-shaped.
Neck, the upper tapering end of bulbs is called the neck.
Nectariferous, bearing honey.
Nectary or *Nectarium*, that part of a flower which produces honey.
Nerves, the strong veins upon leaves or flowers.
Nervimotion, the power of motion in leaves.
Nervose or *Nervine*, composed of nerves.
Neuter, neither male or female.
Nidulant, nestling; lying among any thing as a bird in its nest.
Nidus, the nest of any thing.
Nodding, having a drooping position.
Nodi, the articulations of plants: the place where one joint is articulated with another.
Nodose, having many nodi or knots.
Nodules, small hard knots.
Notch-flowered, having the flower notched at the margin.
Nucumentaceous, producing nuts.
Nucleus, the kernel.

O

Ob is used in the composition of Latin technical terms, to indicate that a thing is inverted; for instance, obovate is inversely ovate, obcordate inversely cordate, and so on.
Occidental, coming from the west.
Ochraceous, having the colour of clay or yellow ochre.
Octandrous, having eight stamens.
Octogynous, having eight styles.
Officinal, any thing that is, or has been, used in the shops.
Oleaginous, having the qualities of oil.
Oleraceous, esculent, eatable.
Olivaceous, having the qualities of olives.
Opercular, covered with a lid.
Operculiform, having the figure and position of a round lid of something.
Operculum, a lid.
Opiate, having the power of opium.
Orbicular or *Orbiculate*, a plane surface circumscribed by a circle.
Orchideous, of or belonging to the natural order of Orchídeæ.
Orifice, an opening.
Ossified, become like bone.
Ova, the eggs of any thing.
Oval, having the figure of an ellipse.
Ovarium or *Ovary*, the part of the flower in which the young seeds are contained.
Ovate, egg-shaped.
Ovato-acuminate, egg-shaped, and tapering to a point.
Ovato-cylindraceous, egg-shaped, with a convolute cylindrical figure.
Ovato-deltoid, triangularly egg-shaped.
Ovato-rotundate, roundly egg-shaped.
Overlapping, when the margin of one thing lies upon that of another, it is said to overlap.
Ovoid, egg-like.
Ovules, the young seeds of plants contained in the ovarium.

P

Palate, the mouth of a ringent flower.
Paleaceous, abounding with chaffy scales.
Palmated or *Palmatifid*, divided so as to resemble a hand.
Panduriform, having the figure of a fiddle.
Panicled, loose-spiked.
Pannary, useful for making bread.
Papilionaceous, butterfly-shaped flowers.
Papillose, producing small glandular excrescences like nipples.
Pappus, the crown of the fruit of Compósitæ, and similar plants.
Papulose, producing small glands like pimples.
Parabolically, in form like a parabola.
Parenchyma, all the parts of plants which consist of cellular tissue only.
Parietal, being attached to the sides of an ovarium instead of its axis.
Patent, spread out or expanded.
Patulous, slightly spreading.
Pectinate, resembling the teeth of a comb.
Pectoral, relating to the breast.
Pedatifid, cut into lobes, the lateral ones of which do not radiate from the petiole like the rest.
Pedicillate, slightly stalked.
Pedicels, small footstalks of flowers.
Peduncle, the common footstalk of flowers.
Pellicle, a thin skin.
Pellucid, bright, transparent.
Peltate, when the petiole is fixed in the disk instead of the margin.
Pencilled, marked in lines as if with a pencil.
Pendulous, drooping, hanging down.
Pentagonal, having five angles.
Pentagynous, having five styles.
Pentandrous, having five stamens.
Pentapetalous, having five petals.
Perennial, lasting many years without perishing.
Perfoliate, when the stem passes through the base of the leaf.
Perianthium, the envelope that surrounds the flower; this term is applied when the calyx cannot be distinguished from the corolla.
Pericarp, the seed vessel.
Perichætial, leaves which in mosses surround the base of the stalk of the theca.
Perigynous, inserted into the calyx.
Peristome, the rim which surrounds the orifice of the theca of a moss.
Perithecium, *Peridium*, or *Perisporium*, different kinds of envelopes of the reproductive organs of Fúngi.
Persistent, remaining, not falling off.
Pervious, having a passage through which anything can be transmitted.
Petaloid, like a petal.
Petals, divisions of the corolla.
Petiolate, having footstalks.
Petioles, footstalks of leaves.
Petiolules, little petioles.
Pezizoid, like a Peziza; a kind of fungus resembling a cup in figure.
Phænogamous, such plants as are visibly furnished with sexual organs.
Pharmaceutical, relating to the art of pharmacy.
Pileate, having a cap or lid like the cap of a mushroom.
Pileus, the cap of a mushroom.
Piliferous, bearing hairs.
Piliform, formed like down or hairs.
Pilose, slightly hairy.
Pimpled, covered with minute pustules resembling pimples.
Pinnæ or *Pinnulæ*, the segments of a pinnated leaf.
Pinnate, a leaf is so called when it is divided into numerous smaller leaves or leaflets.
Pinnatifid, a leaf is so called when it is divided into lobes from the margin nearly to the midrib.
Piquancy, sharpness, pungency.
Pisiform, formed like peas.
Pistillum or *Pistil*, the columnar body situate in the centre of a flower, consisting commonly of three parts, viz. the ovarium, style, and stigma.
Pitchers, hollow leaves so called.
Pith, medulla occupying the centre of a stem or shoot.
Pituitous, discharging mucus.
Plane, flat.
Plano-compressed, compressed down to a flattish surface.
Plethoric, having a full habit.
Plicate, plaited.
Plumose, feathery, resembling feathers.
Plumula, the young leaves in the embryo.
Plurilocular, having many cells.
Pod, a kind of seed vessel such as that of the pea tribe.
Polyandrous, having more stamens than twenty.
Polygamous, a plant is said to be polygamous when

some flowers are male, others female, and others hermaphrodite.
Polygynous, having numerous styles.
Polypetalous, having many separate petals.
Polyspermous, having many seeds.
Pome, an apple.
Pores, apertures in the cuticle through which transpiration takes place.
Porrect, extended forward.
Pouch, a little sack or bag at the base of some petals and sepals.
Prænomen, the first name of several; in plants it is the same as the generic name.
Precocity, ripe before the usual time.
Prismatic, formed as a prism.
Processes, protrusions either natural or monstrous.
Proliferous, a plant is said to be proliferous when it forms young plants in abundance about its roots.
Prominences, protuberant risings from the surface.
Propendent, hanging forward and downward.
Prurient, stinging.
Pubescence, down closely pressed to the surface.
Pullulating, budding.
Pulverised, reduced to powder.
Pulvinate, become cushion-shaped.
Pulvinuli, little cushions.
Punctiform, formed like points.
Pungent, stinging or pricking.
Pustular or *Pustulate*, covered with glandular excrescences like pustules.
Pustules, pimples or little blisters.
Pyriform, shaped like the fruit of a pear.

Q

Quadrangular, four-angled.
Quadrifarious, arranged in four rows or ranks.
Quadrifid, divided four times.
Quadriglandular, having four glands.
Quaternary, succeeding by fours.
Quaternate-pinnate, pinnate; the pinnæ being arranged in fours.
Quinate, in fives.
Quinquefid, divided into five.
Quintuple, five times multiplied.

R

Racemes, a particular arrangement of flowers, when they are arranged around a filiform simple axis, each particular flower being stalked.
Racemose, flowering in racemes.
Rachis, that part of a culm which runs up through the ear of corn, and consequently the part that bears the flowers in other plants.
Radiant or *Radiate*, a flower is said to be radiant, when, in a cluster or head of florets, those of the circumference or ray are long and spreading, and unlike those of the disk.
Radical, proceeding from the root.
Radicant, producing roots from the stem.
Radicule, that end of the embryo which is opposite to the cotyledons.
Radius, the ray of compound flowers.
Ramenta, little brown withered scales with which the stems of some plants, especially ferns, are covered.
Ramentaceous, covered with ramenta.
Ramifications, subdivisions of roots or branches.
Ramose, branchy.
Ramuli, twigs or small branches.
Raphe, in seeds this is the channel of vessels which connects the chalaza with the hilum; in umbelliferous plants it is the line of junction of the two halves of which their fruit is composed.
Receptacle, that part of the fructification which supports the other parts.
Recesses, the bays or sinuses of lobed leaves.
Recurved, bent backward.
Recurvo-patent, bent back and spreading.
Reflexed, bent backward.
Reflexed recesses, sinuses of leaves which are bent backward from the ordinary direction of the surface of a leaf.
Reniform, kidney-shaped.
Repand, a leaf having a margin undulated and unequally dilated is said to be repand.
Repando-dentate, repand and toothed.
Replicate, folded back.
Resolutive or *Resolvative*, having the power to dissolve.
Resolvent, having the power of dissolving.
Restringent, astringent.
Resupinate, inverted in position, so that that which was in front becomes at back.
Reticulated, resembling a net.
Retuse, abruptly blunt.
Revolute, rolled back.
Rhomboidal, like a rhombus.
Rhomboid-ovate, rhomboidally egg-shaped.
Rib, the projecting vein of any thing.
Rigid, stiff.
Ringent, gaping.
Ringing, making an incision resembling a ring all round a branch.
Rotate, a monopetalous corolla, the limb of which is flat and the tube very short, is called rotate.
Rotundo-ovate, roundly egg-shaped.
Rubefacient, any thing which reddens the skin, or raises slight cutaneous inflammation.
Rudiment, when an organ is imperfectly developed, botanists call such developement a rudiment.
Rufous, reddish, orange-coloured, or rusty.
Rugose, rough or coarsely wrinkled.
Rugulose, finely wrinkled.
Runcinate, hooked back, applied to the lobes of leaves.
Runcinato-dentate, hooked back and toothed.
Runners, procumbent shoots which root at their extremity.
Rusty, rust-coloured.

S

Saccate, bagged; having a bag or pouch; as many petals.
Sagittate, shaped like an arrow-head.
Samara, a kind of winged seed vessel; the same as what the English call key.
Sapid, agreeable to the palate.
Saponaceous, soapy.
Sarmentose, producing sarmenta or runners.
Sawed, resembling the teeth of a saw.
Scabrous, rough with little asperities.
Scales, any small processes resembling minute leaves; also the leaves of the involucrum of Compósitæ.
Scandent, climbing.
Scape, a stem rising from the root and bearing nothing but flowers.
Scariose or *Scarious*, membranous and dry.
Schistous, rocky, formed of the rock called schist.
Scion, a shoot intended for a graft.
Scoriæ, cinders.
Scrobiculate, excavated into little pits or hollows.
Scrotiform, formed like a double bag.
Scurfy, covered with scales resembling scurf.
Scutate, formed like an ancient round buckler.
Secund, arranged on one side only: the same as unilateral, which is better.
Sedges, a tribe of marsh plants so called.
Segments, parts of any thing.
Semi-, half.
Seminal, belonging to the seed.
Semination, seeding.
Sepals, the segments of the calyx.
Septa, the partitions that divide the interior of the fruit.
Septiferous, bearing septa.
Serrated, like the teeth of a saw.
Serrulations, notchings like those of a saw.
Sessile, without footstalks.
Setaceo-rostrate, having a beak with the figure of a bristle.
Setaceous, resembling a bristle in shape.
Setæ, bristles.
Setiform, formed like a bristle.
Setigerous or *Setose*, covered with bristles.
Sheath, the lower part of the leaf that surrounds the stem.
Sherds, the fragments of potting employed by gardeners to drain their flower-pots.
Shield, a broad table-like process in the flower of Stapélia and its allies.
Sialagogue, having the power of exciting saliva.
Silicated, coated or mixed with flint.
Siliceous, flinty.
Silicle, the small round pod of Cruciferæ.
Silique, the long taper pod of Cruciferæ.

Simple, the reverse of compound.
Sinuate or *Sinuose*, bending in and out.
Sinuato-dentate, sinuate and toothed.
Sinus, the bays or recesses formed by the lobes of leaves or other bodies.
Soboliferous, producing young plants from the root.
Soddened, soaked.
Somniferous, causing sleep.
Soporific, causing sleep.
Sori, the patches of fructification on the back of the fronds of ferns.
Spadix, a spike protracted from a spatha.
Spatha, a broad sheathing leaf enclosing flowers arranged upon a spadix.
Spathaceous, furnished with a spatha.
Spathulate, shaped like a spatula, a knife so called.
Sphacelate, withered or dead.
Sphærical, round like a sphere.
Spheroidal, almost like a sphere.
Spherules, minute spheres.
Spike, flowers sessile upon a long rachis.
Spines, indurated branches or processes formed of woody fibre, and not falling off from the part that bears them.
Spiniform, formed like a spine.
Spinous, full of spines.
Spinulescent, having a tendency to produce small spines.
Spinulose, covered with small spines.
Spiral, circularly involved.
Sporules, that part in Cryptogamous plants which answers to the seeds of other plants.
Sporuliferous, bearing sporules.
Spurious, counterfeit.
Spurs, long processes resembling horns produced by various parts of the flower.
Squamiform, like scales.
Squarrose, spreading rigidly at right angles, or in a greater degree.
Stamen, the male organ of a flower.
Staminiferous, producing stamina.
Standard, the upper segment of the flower of Leguminósæ.
Stellate, in the manner of a star.
Stellulate, resembling little stars.
Sterile, barren.
Sternutatory, qualities which provoke sneezing.
Stigma, the female organ of a flower.
Stimulating, exciting.
Stimuli, stinging hairs.
Stipes, the stalk of Fúngi.
Stipitate, having a short stalk.
Stipulaceous, having appendages called stipulæ.
Stipulary, occupying the place of stipulæ.
Stipules, small scales at the base of the petiole of certain leaves.
Stoloniferous, having creeping roots.
Stolons, root shoots.
Stomachic, relating or agreeable to the stomach.
Strangury, a disease, and produced on plants by tight ligatures.
Strata, layers, beds.
Striæ, small streaks, channels, or furrows.
Striated, having striæ.
Strigæ, little, rigid, unequal, irregular hairs.
Strigose, having strigæ.
Strophiolate, surrounded by protuberances.
Struma, a wen or protuberance.
Strumose or *Strumous*, covered with strumæ. arium
Style, the stalk which intervenes between the and stigma, bearing the latter.
Styptic, having the power to staunch blood or some-
Sub, in composition, signifies subordina what.
Succulent, fleshy and filled with juice. perspiration.
Sudorific, having the power of produc
Suffruticose, shrubby in a slight degr
Sulcate, furrowed. of any thing.
Supernatant, floating on the surfac
Suppurate, to generate matter. nded.
Supra-decompound, doubly com
Surculi, young shoots. cohesion of two parts.
Suture, the line formed by th e nineteenth class of the
Syngenesious, belonging to sexual system.
Synthetical, combining; o osed to analytical.

T

Tails, the long feathery or hairy terminations of certain fruits.
Tap-root, a root which penetrates deep and perpendicularly into the ground without dividing.
Teated, resembling the figure of the teat of animals.
Tendrils, the curling twining organs by which some plants lay hold of others.
Terebinthinate, consisting of turpentine.
Terete, taper, round and long.
Terminal, ending, or at the top.
Ternary, consisting of threes.
Ternate, growing together in threes.
Tessellated, variegated by squares.
Testa, the skin or integument of the seed.
Testaceous, having a pale brown colour.
Tetrachotomous, a stem that ramifies in fours.
Tetrandrous, having four stamens.
Tetrapetalous, having four petals.
Tetrasepalous, having four sepals.
Thalamus, that part of a flower which rises from below the ovarium and sometimes supports the outer envelopes.
Thallus, that part which bears the fructification of Lichens.
Thecæ, the cases that contain the sporules of Cryptogamic plants.
Threads, long delicate hairs.
Throat, the orifice of a flower.
Thyrse, a kind of dense panicle like that of the lilac.
Thyrsoid, resembling a particular kind of panicle called a thyrsus.
Tomentose, densely and closely hairy.
Tomentum, dense close hair.
Tonic, bracing, strengthening.
Toothed, divided so as to resemble teeth.
Toothletted, furnished with little teeth.
Topical, local, confined to some partic ar place.
Torose, uneven; alternately elevated nd depressed.
Tortuose, twisted.
Torulose, slightly torose. h see.
Torus, the same as thalamus, w apezium.
Trapeziform, in the shape of
Trapezoid, like a trapezium. ens.
Triandrous, having three s d in threes.
Trichotomous, branches d points.
Tricuspidate, having th iple rank.
Trifarious, arranged i
Trifid, divided in th e cells.
Trilocular, having g as if furnished with three petals.
Tripetaloid, appe three petals.
Tripetalous, hav g three sides or angles.
Triquetrous, h ced to powder by pounding.
Triturated, l ging to the torrid zone.
Tropical, b nt, as if cut off.
Truncate, covered with knobs or tubercles.
Tubercu bearing solid fleshy roundish roots like the
Tuber o.
ps, roots so called.
Tu d, swelling.
T nic, a coat.
Tunicated, having a coat.
Turbinate, having the figure of a top.
Turgid, swollen, puffed up.

U

Umbellules, divisions of an umbel.
Umbels, the round tuft of flowers produced by the carrot, &c.
Umbilicus, the cord which attaches the seed to the receptacle.
Umbonate, having a top in the centre like that of the ancient shield.
Unarmed, destitute of prickles or spines, which are the arms of plants.
Uncinate, hooked.
Unctuous, fat, oily.
Undulate, waved.
Undulato-rugose, rugose or rugged and waved.
Unguiculated, furnished with a short unguis.
Unguis, the taper base of a petal.
Unilateral, one-sided.
Unilocular, one-celled.
Unisexual, being of the sex.

Urceolate, pitcher-shaped.
Uterine, belonging to the womb.
Uterus, the womb.
Utricle or *Utriculus*, a little bottle or bladder.

V

Valvular or *Valved*, consisting of valves or seed cells.
Varicose, swollen here and there.
Vascular, consisting of tissue in a very succulent enlarged state.
Vaulted, formed or placed like the roof of a vault.
Veneering, the art of covering one kind of wood with thin plates of another kind.
Ventricose, inflated.
Veratrine, the active principle of Verátrum.
Vermifuge, that which expels worms.
Vernacular, native.
Vernal, belonging to the spring.
Versatile, swinging lightly on a stalk so as to be continually changing direction.
Vertex, the uppermost point.
Vertical, perpendicular.
Vertically compressed, that is depressed.
Vertilinear, the same as rectilinear; in a straight line.
Vesicatories, blistering plasters.
Vesicles, hollow excrescences resembling bladders.
Vexillum, a standard; the upper petal of a papilionaceous flower.
Villous, shaggy, with long loose hair.
Virescent, green, flourishing.
Virgate, twiggy.
Viscid or *Viscous*, adhesive, clammy.
Vivacious, lively.
Viviparous, bearing young plants in the place of flowers and seed.
Vulnerary, useful in the cure of wounds.
Vulviform, like a cleft with projecting edges.

W

Wattled, having processes like the wattles of a cock.
Welted, flaccid, drooping.
Whorls, leaves inserted round a stem.
Wing, in botany, signifies a membranous border, wherewith many seeds are supported in the air when floating from place to place.

Z

Zones, stripes or belts.

INDEX.